Public Disclosure Authorized
Public Disclosure Authorized
Public Disclosure Authorized
Public Disclosure Authorized

LATIN AMERICA
AND CARIBBEAN

BACKGROUND NOTE 7. MEASURING THE POTENTIAL IMPACT OF DEVELOPING THE LITHIUM VALUE CHAIN IN ARGENTINA

World Bank Group

COUNTRY CLIMATE AND DEVELOPMENT REPORT

November 3, 2022

Table of Contents

1. Introduction 3
2. Lithium value chain in Argentina 6
3. Methodology and data sources 10
   3.1. Argentina 2017 MRIO matrix with the LVC: data sources and treatments 11
   3.2. MRIO model for Lithium simulations 24
4. Design of lithium value chain scenarios 27
   4.1. Lithium extraction and compounds production 28
5. Analysis of the development of LVC simulations 36
   5.1. Conservative vs. moderate & optimistic LVC scenarios impacts in 2022 36
   5.2. Comparison of the three LVC scenarios impacts in 2025 and 2030 40
6. Final remarks 45
7. References ..... Error! Bookmark not defined.

Appendix 1. Lithium value chain information 49
Appendix 2. MRIO: methodological details 53
Appendix 3. 2017 Argentina MRIO matrix - 35 sectors table 55
Appendix 4. Satellite employment account 56
Appendix 5. Information to the prospective scenarios of LVC design 57
Appendix 6. LVC simulation scenarios - additional results 59

Background Note 7. Measuring the potential impact of developing the lithium value chain in Argentina: a multi-regional Input-Output analysis

Prepared by Martín Obaya (CENIT-EEYN-UNSAM), M. Priscila Ramos (MESi-IIEP) and Carlos A. Romero (MESi-IIEP)
Research assistants: Pablo Bertin (MESi-IIEP) and Juan Mercatante (MESi-IIEP)
World Bank coordination: Julie Rozenberg and Mariana Conte Grand

Argentina has a privileged situation for the Lithium Value Chain (LVC) development since it accounts for 22 percent of worldwide lithium resources and a great number of exploration projects in lithium extraction concentrated in three provinces: Catamarca, Jujuy, and Salta. Nevertheless, LVC is not only lithium primary activity but also it adds midstream and downstream activities, such as the production of lithium cells and battery packs, which are finally demanded by the production of electric vehicles and for renewable energy storage. The objective of this report is to present and analyze the potential quantitative socioeconomic impacts of the development of the LVC in Argentina at national, regional, and sectoral level. To address this purpose, we have built a multi-sectoral (35 sectors) and multi-regional (3 provinces and the rest of the country) Input-Output (MRIO) matrix with its associated Satellite Account of Employment (SAE) for 2017. The construction of a MRIO matrix requires national and sectoral information integrated in the form of a matrix (national IO matrix) as the starting point to produce the regional one. The chosen year must be the most recent and stable one for the economy (no crisis, no pandemic, no war) and with full national accounts and sectoral data available. Therefore, we have chosen 2017 as the base year for the MRIO matrix and we took the 2017 Argentina Social Accounting Matrix from Chisari et al. (2020) as reference to include the LVC with a regional split of all the economy. Both the MRIO matrix and the SAE are the calibration base for an MRIO model used as simulation tools. Three prospective scenarios about the LVC development at three temporal horizons (2022, 2025 and 2030) have been designed considering official targets for sectors which could be a source of demand for lithium. Results highlight that under all scenarios and from now until 2030 net socioeconomic impacts are positive for production, GDP, employment, tax revenue and exports. The location of lithium investment and production leads to great direct impacts in each of the three provinces. However, spillover effects to the rest of the economy (other sectors and regions) become significant with a deeper ambition on the development of the LVC, particularly with large scale lithium projects that demand inputs and services from other regions and, in a minor way, when downstream LVC sectors start producing (cells and battery packs) by 2030.

1. Introduction

The world is experiencing new changes in their productive matrix, encouraging more sustainable energies as it is mentioned in the Sustainable Development Goals 7 (SDG#7) of the United Nations. In this way, institutions at national and international levels try to improve not only the use of clean energy, but also decrease the use of fossil fuels. For this reason, it is important to highlight the measurement and to register the evolution of renewable energy, energy efficiency, international financial flows and other new sources that allow expanding the possibilities of acceleration to new challenges in terms of the use of energy.[1] At the global level, the decarbonization process is projected to be more intensive in mineral resources. Against this backdrop, lithium assumes a critical nature, as it is used as an input in the production of lithium-ion batteries, which are primarily used in the electromobility industry and in renewable energy storage. The growing demand of lithium pushed up the price of lithium compounds from 2015 to 2018, and after a sharp drop, the price started to recover from 2020. Despite the critical role lithium plays in the global transition towards a post-fuel society, it is worth stressing that the lithium market is a niche in the global mineral market. For instance, in 2020, the copper market (US$ 123,475 millions) was 48 times larger than the lithium market (US$ 2,567 millions).[2]

As the key role of lithium consolidated at a global level, lithium-rich countries in South America started to consider it as a strategic resource. They intended to improve their capacity to capture rents and, also, to develop lithium-related downstream linkages, especially in the battery industry. This effort, however, faces significant obstacles. The battery market is highly concentrated in a few Asian countries (and in China). Also, the development of a battery industry is highly dependent on the existence of an electromobility industry since the value chain privileges the co-location of manufacturing activities (Obaya et al.,2021). As a result, it is not easy for new entrants to play in those markets. Argentina is one of the countries with the largest lithium resources worldwide and this asset could become a growth driver for the country and, especially, for the lithium-rich provinces. Argentina belongs to the so-called “Lithium triangle” (LT) (see Map 1), a geographical area shared with Chile and Bolivia that accounts for 29 percent of global production, 54 percent of reserves and 58 percent of identified resources at the world level (USGS 2021).

Although Argentina has 22% of world resources, its participation in reserves and global production falls to 8% and 8%, respectively. In turn, Argentina also is the country with the largest number of lithium projects in the world. According to the Secretary of Mining (2021), there are 22 projects at an advanced stage of development and more than 40 at an early stage (see Table 1.1 in Appendix 1). Despite the potential of the country, as March 2022, there were only two projects operating at an industrial scale of production:

i) Minera del Altiplano (owned by the US firm Livent), which has been operating in *Salar del Hombre Muerto* (Catamarca) since 1998.

ii) Sales de Jujuy, a joint venture between the Australian firm Allkem (previously *Orocobre*), the Japanese Toyota Tsusho Corporation and a company owned by the province of Jujuy, *Jujuy Energía y Minería* Sociedad del Estado (JEMSE). This firm has produced lithium compounds in the *Salar de Olaroz* in Jujuy since 2015.

[1] For more information: https://trackingsdg7.esmap.org/

[2] Own calculation based on data from the World Bank (price of copper), Comtrade (price of lithium carbonate) and the Mineral Commodities Summaries of the United States Geological Survey (quantities).

Map 1. Lithium triangle in South America

Source: The Economist

The role of China as an investor in the Argentinean lithium industry has grown steadily in the last few years. In early 2020, Ganfeng Lithium Co. procured a 51 percent of Lithium Americas Corp project in Jujuy. They will jointly operate Minera Exar, which is currently building the infrastructure for production, and is expected to start its operations in 2022. The firm also has a participation in the project Mariana, in the province of Salta

Lithium endowments and the proliferation of lithium-related projects in Argentina are feeding the ground for the future development of the Lithium Value Chain (LVC) in this country. Moreover, the realization of lithium production projects and potential investment in lithium-related downstream industries, are important for the regional development in the country. Lithium resources are concentrated in three provinces, Catamarca, Jujuy and Salta, and the development of some links of the LVC could not only increase their gross geographical products and employment, but also generate spillover effects on the rest of the country due to the intersectoral and regional productive links (so called indirect and induced effects in terms of an IO model impacts).

This context motivates the aim of this project, which is to quantify the potential economic impact of developing the LVC in Argentina, focusing on regional impact for the three provinces rich in this natural resource: Catamarca, Salta, and Jujuy.

For that purpose, we developed a Multi-Regional Input Output (MRIO) model calibrated with a MRIO matrix and its Satellite Account of Employment (SAE). The model characterizes the three mentioned provinces and the rest of Argentina as a fourth region. The MRIO matrix and model has 35 sectors from which 6 of them make up the LVC: lithium as a primary process (upstream); the production of lithium cells and the battery assembly process as two sectors in the production of lithium-ion batteries; the production of electric vehicles and the production of machinery and equipment for the renewable power generation; and electricity generation by renewable sources itself to close the LVC (all these sectors are considered downstream).

Based on this developed tool, we have run three scenarios that offer different configurations of the LVC in Argentina: conservative; moderate; and, optimistic. Each of the three scenarios displays a temporal dimension with objectives to be reached in 2022, 2025 and 2030 for each of the sectors of the LVC.

The main results suggest that investment and production of lithium in the three lithium-rich provinces directly impact on their geographical gross product and employment. However, when the scale of lithium production, and, marginally, the development of LVC downstream sectors by 2030 in more ambitious scenarios, spillover (indirect and induced) effects become not negligible. In this sense, the value added and employment increase also in the rest of the country and in the sectors that are not directly part of the LVC but provide inputs and services to these and other sectors, and to households whose purchasing power increases. The deeper ambition in the development of the LVC in Argentina (scale of production and LVC linkages), the greater the spillover effects on socioeconomic variables across sectors (not necessarily LVC sectors) and regions of the country (not exclusively the three lithium-rich provinces).

This final report is organized as follows. Section 2 describes the current and potential LVC in Argentina, identifying the capacity of development of each sector in the chain. Most of this information has been taken into account to develop the required datasets including the LVC (structures of costs and sales for the 6 sectors in the LVC) and the design of scenarios to be simulated. Section 3 presents the methodological approach. We describe the data sources and treatment to build the MRIO matrix and its associated SAE with the inclusion of the LVC's sectors. Moreover, in this section we present the characteristics of the MRIO model used for this project. In section 4 we describe the assumptions of the three prospective scenarios concerning the development of the LVC, based on national, regional and global perspectives, particularly on the lithium-ion battery (cells), electromobility sectors and renewable energy storage as demanders of the lithium carbonate. In section 5, we present and analyze the LVC scenario results at national, regional and sectoral level for the three LVC scenarios in the three horizons. Finally, in section 6, the report summarizes and discusses main findings.

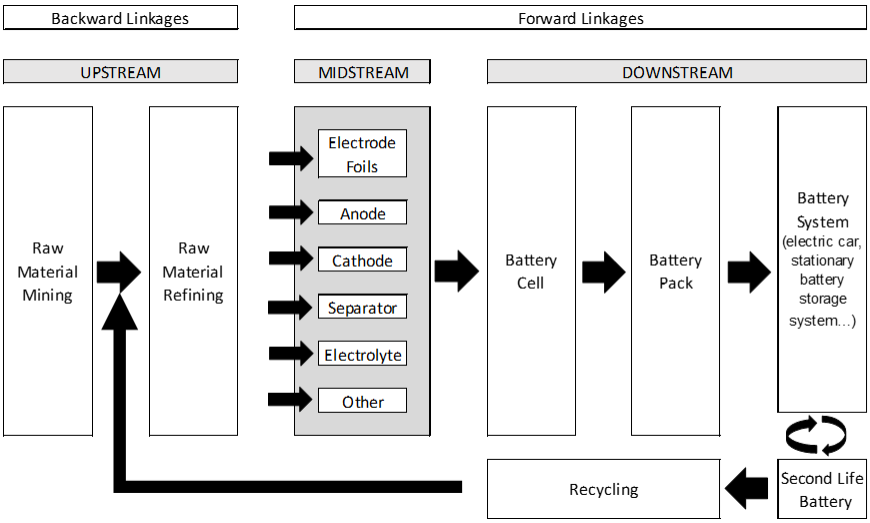
2. Lithium value chain in Argentina

Figure 1 presents a simplified scheme of the lithium-ion battery value chain. Argentina and the countries from the so-called lithium triangle participate in the "upstream" segment, corresponding to lithium extraction activities and the production of lithium carbonate and lithium hydroxide. In salt flat exploitation the boundaries between these two activities, i.e. raw material production and intermediate processing, are blurred (Weimer et al. 2019). For this reason, generally, they are both carried out by the same firms within a confined geographical area. In some cases, however, the upgrading from industrial grade lithium carbonate to a battery grade level is carried out in other locations, closer to the production of cathodes. Differently from South American countries, Australia has large hard-rock, pegmatite-hosted lithium resources. Accordingly, the country specializes in the production of lithium-rich spodumene concentrate. Since 2017, Australia has become the largest producer in the world, relegating Chile to the second position (Figure 3). However, Australia does not manufacture lithium compounds. The bulk of lithium resources extracted from Australian mines is processed in plants located in China to manufacture lithium compounds (in particular, lithium hydroxide).

The mid-stream segment corresponds to the production of battery components (Figure 2). The main components are the electrodes (cathode and anode), the electrolyte, and a separator. During the charging process, lithium ions move from the positive electrode (cathode) and flow to the negative electrode (anode). The discharge process occurs when the ions flow back towards the cathode. The displacement of the lithium ions occurs through the electrolyte, which is the organic medium that provides the conductive pathways for the movement of the ions (Cheng et al. 2019, Duan et al 2020). The separator is a fine porous membrane that allows the transfer of lithium ions while avoiding physical contact of the electrodes avoiding short circuits (Sharova et al. 2020). Lithium is mainly used in the cathode, which has a key role in defining the performance of the battery. The share of lithium in the battery varies in accordance with the cathode technology both in terms of value and mass (Bernhart 2019). In a NCM cathode battery, lithium only represents 4.9 percent of the cathode material and 1 percent of the whole battery pack (European Parliament 2018).

The production of cathodes is mainly concentrated in Asia, which accounts for almost two-thirds of the world output (Figure 4). Sumitomo Chemicals, Hitachi Chemical, LG Chem, and Samsung SDI are among the main producers. However, Europe and the United States also have important companies which have an outstanding presence in the cathode industry, like BASF, Umicore, and 3M. There is no production of cathodes in the countries of the lithium-triangle. Within the Latin American region, Mexico has been the country which has been able to attract investment in this industry, mainly thanks to its integration to the North American automotive production network (Fact.MR 2019)

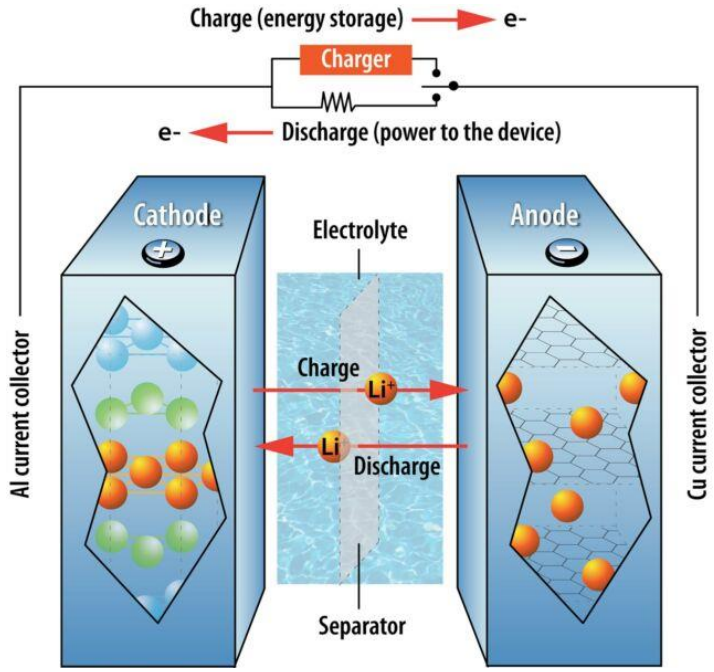
Figure 1. Lithium-based linkages in the lithium-ion battery production process



Source: Own elaboration

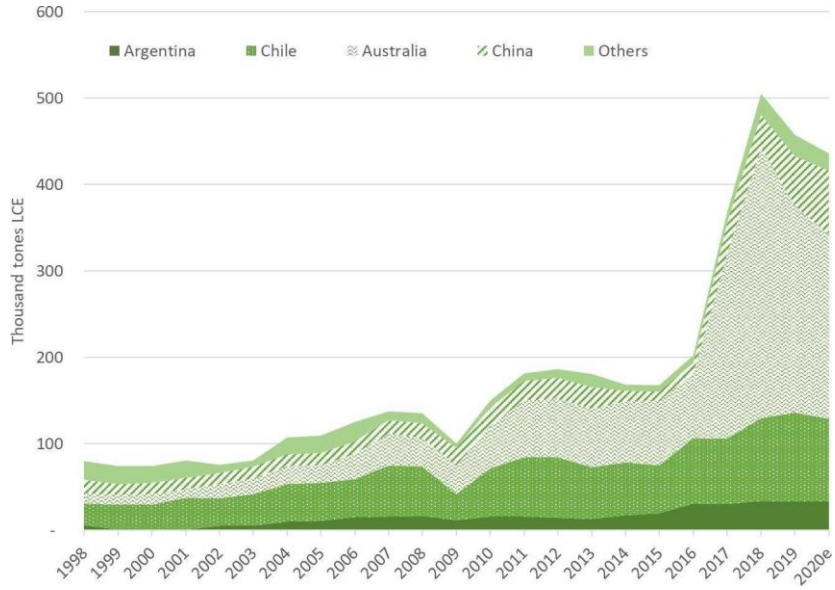
The downstream segment corresponds to the production of battery cells and packs. Japan, Korea and, especially, China have a dominating position in the production of these goods (Table 1). Resource-producing countries in upstream segments do not carry out industrial-scale activities in midstream or downstream segments.

Figure 2. Main components of a lithium-ion battery cell



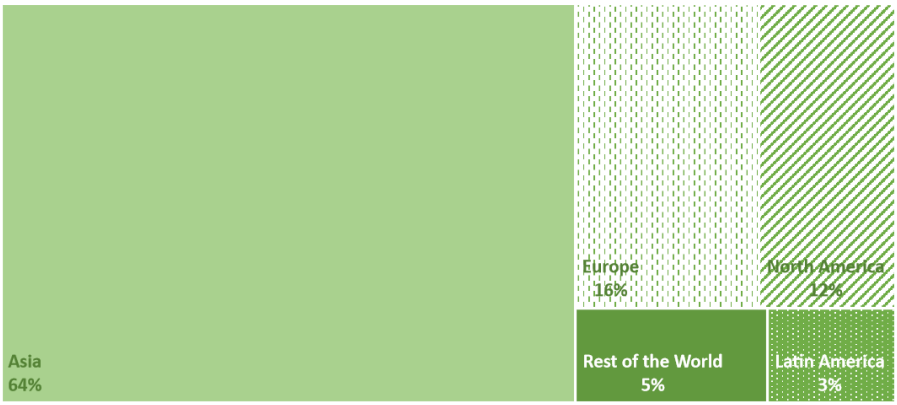
Source: Argonne National Laboratory

Figure 3. Production of lithium, 1998-2020 (thousand metric tons LCE)



Source: Own elaboration based on USGS
Notes: LCE = lithium carbonate equivalent; 2020e denotes estimate; "Others" excludes the United States.

Figure 4. Production value of battery cathodes, 2019 (percent)



Source: Fact.MR 2019

Table 1. Production capacity of battery cells, 2018

Country	Production capacity of LiB cells for electric vehicles (MWh)	Share	Production capacity of LiB cells for other uses (MWh)	Share
China	50.67	44%	67.564	90%
Japan	19.414	17%	3.065	4%
South Korea	17.874	16%	673	1%
United States	22.016	19%	2.75	4%
Europe	2.4	2%	226	0%
Rest of the World	2.11	2%	1	1%
TOTAL	**114.484**	**100%**	**75.278**	**100%**

Source: Mayyas, Steward & Mann 2019

Finally, as shown on Figure 1, the LVC includes battery recycling. This segment is gaining relevance as it would allow the value chain to gain circularity. It would also allow battery-producing countries to reduce their dependence on lithium suppliers. However, techniques for achieving efficient recovery levels are still under development, especially in China, the United States, and Europe, where concern over supply has increased over the years.

Mining has been growing in the last decades in Argentina. The relevance of employment, gross production value and exports of this sector increased in the total economy. In fact, total employment doubled from 10,500 to 24,500 between 2001 to 2019 and exports grew from 0.6 percent of total exports in 1997 to 4.1 percent of total export in 2019 (Schteingart & Allerand 2021). Particularly, metalliferous and lithium mining expose a key play in the mining sector in Argentina and show a virtuous relationship with other sectors. As it is mentioned in Schteingart & Allerand 2021, the metalliferous and lithium mining not only is essential into the mining sector but also it relates with manufacturing industry, construction, trade, professional services and restaurant and hotels. These sectors provide inputs for the development of lithium and metalliferous mining in Argentina. According to the interrelationships between sectors, Argentina shows a potential sector driver for economic growth and particularly for the provinces that are involved in the future lithium projects. This document will analyze in detail that potential.

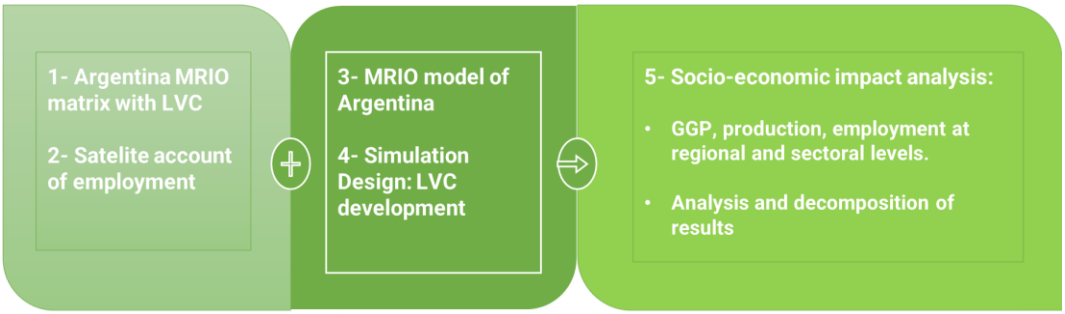
3. Methodology and data sources

To analyze the impact of the development of the LVC in Argentina, the MRIO analysis was chosen. A multi-regional and multi-sectoral approach allows measuring not only the intra-chain impacts, but also the socio-economic relationships with other chains and sectors of Argentina's regions. In this sense, the MRIO analysis can be used to estimate the potential direct impacts of lithium production per se, the indirect impact on other productive sectors from the same and other regions, and the induced impact due to the increase in households' income, at both national and regional levels. A similar analysis was developed for *Vaca Muerta* using a regional input-output table isolating the province of Neuquén from the rest of the country (Romero et al. 2018).

The application of this methodology helps not only to meet the final objective of this project, that is obtaining the estimates of production and employment, but also to organize an analysis scheme and determine the information requirements. The latter is essential for this project since the development of the LVC would lead to profound changes in the economic structure at regional and national levels that cannot be fully understood with the mere application of conventional input-output analysis. For example, it would be necessary to design, in a prospective way, the development of latent lithium-related activities (e.g., lithium-ion batteries, electric cars, distributed power generation) or even the same activity but under technological configurations (e.g., lithium cells factories only or even assembly of batteries). Moreover, for the data development and the design of scenarios processes we also need to decide the potential energy substitution when increasing the share of non-conventional renewable sources -as part of the lithium demand chain- in the energy matrix, to identify the possible bottlenecks in the development of this production chain (e.g., regional or national fiscal measures, investment requirements, technological or human resources limitations, etc.), and finally, to evaluate the possibility to carry out sensitivity analysis on changes in key lithium chain activities and households' preferences.

Figure 5 presents the scheme for the MRIO analysis to be developed for the impact evaluation of the LVC in lithium-rich Argentina's regions. This approach could be described in five main steps.

Figure 5. The MRIO model scheme for LVC simulations



Source: Own elaboration

The first step concerns the collection and adaptation of the available information about economic sectors of the regions of interest and particularly of lithium-related activities. In this sense, it is required to have the MRIO matrix or a Social Accounting Matrix (SAM) at the regional level. If the analysis is focused on specific sectors, such as in the lithium case (lithium carbonate, electrodes, battery cells and packs, electric cars, solar/wind energy storage, etc.), their opening in the matrix is also needed. If the activity already exists in the region's economic structure, we are required to construct the current costs and sales structures based on firms in operation. Otherwise, when a particular activity of the LVC is not currently working in each region, international information of the

structure of costs will be used to include that activity as latent in the regional matrix. Due to the incipient development of the LVC in Argentina, interviews and the lithium-expert knowledge is essential to develop in this part of the MRIO matrix.

The second step is also related to the data development process. In this case we need to build a SAE with the same regional and sectoral detail as in the MRIO matrix. This matrix is complementary to the MRIO and allows to measure the impact on employment at the sector and region levels. The available data allows splitting the employment by occupational activity (dependent registered labor, dependent non-registered labor, independent labor). Thus, the dataset composed by the MRIO matrix plus the SAE is the base of the calibration model for simulations.

The third step in this approach needs to develop the MRIO model. It implies the use of supply and demand input-output models, both considering structural change, including not only the sectoral dimension but also the regional one. Sectoral and regional multipliers will be computed to understand the intra-Argentina links due to the development of the LVC. Working with open and close (on households' demand) versions of the model, we will quantify the total impact and its decomposition into direct, indirect, and induced effects.

The fourth step requires the knowledge of the current situation of the LVC and its prospective trend at international, Latin America, and national level that could push for the development of the LVC in Argentina. The design scenarios simulation will be based on national and international reports for this sector, and on interviews of main actors (firms, research and consultancy institutions, policymakers) in the lithium chain. Section 4 below details the assumptions made for the design of lithium scenarios at different time-horizons. The final design of these scenarios was validated during the presentation of the mid-term report to the WB teams.

The fifth and final step of this approach will allow analyzing national and regional results (GDP, value of production, exports, and employment) and sectoral results (employment, production). The latter are particularly important because they will allow policy makers to analyze potential bottlenecks, sectoral policy needs in some region-activities linked to lithium or regional supplier development, etc.

The remaining section will present, in subsection 3.1, the development of the MRIO matrix and its SAE (steps 1 and 2) and, in subsection 3.2, we will briefly describe the MRIO model (step 3). The design of prospective scenarios in the lithium chain (step 4) are detailed in section 4 and the analysis of results (step 5) in section 5.

3.1. Argentina 2017 MRIO matrix with the LVC: data sources and treatments

One of the specific objectives of this project is to develop a MRIO matrix for Argentina with a comprehensive representation of all sectors in the LVC and its SAE to compute the socio-economic impacts at sectoral and regional levels.

As stated above, the starting point and the framework of the data development process is the Argentina 2017 Social Accounting Matrix (SAM) with 30 sectors at the national level (Chisari et al. 2020). Based on this national matrix, we introduce six new sectors that are relevant in the current and potential LVC in Argentina. These sectors are: lithium extraction (upstream and primary sector); lithium cells for lithium-ion batteries, lithium-ion battery packs, utility scale solar panel installation; electric vehicles and renewable electricity generation.

Simultaneously, the national IO matrix was regionalized into four regions, that are, in this case, the provinces of Catamarca, Salta and Jujuy, rich in the lithium resource (production and investment concentration) and a fourth region that is the rest of the country, that in the scenarios will mainly

concentrate the development of the downstream sectors of the LVC. It is important to note that each of these four regions and the national IO matrix introduce the six new sectors of the LVC in a consistent way. The national IO matrix provides the general values, first, to check the MRIO matrix's closures and second, to establish certain assumptions when provincial information is not available due to the limitations of provincial data.

Nevertheless, the process of a matrix regionalization requires the creation of the intra and inter regional relationships at the sector level. The Flegg Location Quotient (FLQ) method is applied to find the intersectoral coefficients inside each region of the MRIO matrix, and the modified RAS[3] method adjusts the interregional coefficients at the sector level keeping the overall national consistency (see Appendix 2 for more details about FLQ and RAS methods). The result of this process is the 2017 Argentina MRIO matrix that includes the LVC.

This process for the MRIO matrix construction is graphically presented in Figure 6.

Figure 6. Process to develop the 2017 Argentina MRIO matrix with the LVC

Source: Own elaboration

3.1.1. 2017 Argentina Multi-Regional Input-Output Matrix

Getting into the details of the MRIO matrix building process, Table 2 shows a general scheme of the final 2017 Argentina MRIO matrix, showing the regional (four regions) and sectoral (two sectors for this example) interactions. As mentioned before, all same sectors are included in each regional matrix and intersectoral interrelationships are also allowed between the four regions.

More precisely, the scheme in Table 2 shows an economy with 2 sectors for the provinces of Jujuy ("J"), Salta ("S"), Catamarca ("C") and the Rest of Argentina (RA). Each of the quadrants from J-S1 to RA-S2 represent the purchases and sales made by sector 1 (S1) and sector 2 (S2) for each of the provinces as well as the interrelationships of the sectors between the provinces and RA. The sum by

[3] The RAS method is an iterative process that, beginning with an initial matrix *A* and vectors that contains totals for rows and columns, finds a new matriz *A** that respects those totals.

rows of these quadrants represents the vector of intermediate sales (column IS) while the sum by columns represents the vector of intermediate purchases (row IP).

To the right of column IS, are the components of final demand such as investment (I), exports (X), household consumption (CD) and government consumption (CG), the totals being in the right end of the matrix´s scheme. The total demand (column), given the circular flow characteristic, must be equal to the total supply (row). As shown in the scheme, the total supply at market prices is composed of Gross Value Added (GVA), Intermediate Consumption (IC), provincial taxes (T_prov), national taxes net of subsidies (T-S), Factorial Taxes (T_F) and imported consumption (IMC). Total demand and total supply must be consistent in the matrix.

Table 2. Scheme about Multi-Regional Input-Output Matrix of Argentina 2017 and data sources

	J-S1 J-S2	SA-S1 SA-S2	C-S1 C-S2	RA-S1 RA-S2	IS	I	CG	X	CD	TOT.DEM
J-S1 J-S2	FLQ	RAS / Cross Entropy	RAS / Cross Entropy	RAS / Cross Entropy	Intermediate Sales Border: Total demand - Final Demand	MCS2017 + Data for FBKF for distribution assumption	MCS2017+ Data Province Budget	MCS2017 + Provincial Exports by INDEC	MCS2017 + Household survey by INDEC	Domestic Demand at Market Prices - DEM = OF
SA-S1 SA-S2	RAS / Cross Entropy	FLQ	RAS / Cross Entropy	RAS / Cross Entropy						
C-S1 C-S2	RAS / Cross Entropy	RAS / Cross Entropy	FLQ	RAS / Cross Entropy						
RA-S1 RA-S2	RAS / Cross Entropy	RAS / Cross Entropy	RAS / Cross Entropy	FLQ						
IC	Intermediate Consumption Border - Source: MCS2017 + Province Account by INDEC+ Province Gross Product Data									
GVA	MCS 2017 + Province Account by INDEC+ Province Gross Product Data									
T_ PROV	Province budgets + Tax Collection by Province									
T-S	MCS2017 + Province budgets + Tax Collection by Province									
T_F	MCS2017									
IMC	MCS2017									
TOT. SUP	National Supply at Market Prices									

Final Demand (FD)

Source: Own elaboration

Even when in the MRIO matrix scheme the example is presented with two sectors, the final MRIO matrix keeps the same structure for the four regions of the country but even expanded to the complete set of sectors, from the LVC and others (Table 4).

MRIO data sources

To construct the MRIO matrix, different data sources are considered for the provinces and as identified in the previous scheme, the SAM for Argentina valued at 2017 prices, is one of the key inputs for the assembly of this matrix as it was introduced before. Intermediate purchases, intermediate sales and value added come from INDEC provincial accounts for 2004 and the Gross Regional Product (GRP) for each of the provinces is provided by provincial statistical institutions. Following the MRIO matrix scheme on the supply side, tax information comes from provincial budgets, where the collection of the gross income tax - *impuesto a los ingresos brutos* - is the main tax source for the provincial governments' income (National Ministry of Economy). Imported content is regionally distributed from national data coming from the SAM 2017.

On the demand side of the MRIO matrix scheme, the column-vector for investment is taken from the SAM 2017, making a regional distributional assumption according to the provincial gross fixed capital formation (GFCF). Provincial data for exports are obtained from the INDEC, while household consumption comes from the INDEC's *Encuesta de Gasto de los Hogares* (ENGHo) and government expenses from provincial governments' budgets. These sources complete the matrix on both the row (production) and column (demand) sides.

As a summary, Table 3 shows main sources of information for the estimation of MRIO matrix.

Table 3. Main data sources for the construction of the 2017 Argentina MRIO matrix

Data Sources	Year	Links
SAM Argentina 2017 (Chisari et al., 2020)	2020	https://iiep-baires.econ.uba.ar/uploads/publicaciones/522/archivos/1.pdf
System of National Accounts (INDEC)	2017	https://www.indec.gob.ar/indec/web/Nivel4-Tema-3-9-47
Balance of Payments (INDEC)	2017	https://www.indec.gob.ar/indec/web/Nivel4-Tema-3-35-45
Gross Geographical Product (Ministry of Finance and Department of Provincial Statistics)	2005 y 2017	https://www.argentina.gob.ar/economia/politicaeconomica/informes-provinciales http://dipec.jujuy.gob.ar/indicadores-economicos/producto-bruto-geografico/ http://estadisticas.salta.gov.ar/web/archivos/anuarios/anuario2018-2019/ANUARIO%202019%20-%20WEB.pdf
Savings-Investing-Public Financing (Ministry of Finance)	2017	https://www.economia.gob.ar/onp/ejecucion/2017
Consolidated Budget per province (Non financial Public Administration)	2017	https://www.economia.gob.ar/dnap/ejecuciones.html
National taxes on productive sectors (INDEC) (AFIP)	2017	https://www.afip.gob.ar/institucional/estudios/anuario-estadisticas-tributarias/ https://sitioanterior.indec.gob.ar/nivel4_default.asp?id_tema_1=3&id_tema_2=9&id_tema_3=114
Productive and factorial taxes (AFIP)	2017	https://www.afip.gob.ar/institucional/estudios/anuario-estadisticas-tributarias/
Provincial taxes series (Ministry of Finance)	2017	https://www.economia.gob.ar/dnap/recursos.html
Provincial Accounts 2004 (INDEC)	2004	https://www.indec.gob.ar/indec/web/Nivel4-Tema-3-9-138
International trade (INDEC)	2017	https://www.indec.gob.ar/indec/web/Nivel4-Tema-3-2-79
Investment (INDEC)	2017	https://www.indec.gob.ar/indec/web/Nivel4-Tema-3-9-47
ENGHo 2017/2018 (INDEC)	2017	https://www.indec.gob.ar/indec/web/Nivel4-Tema-4-45-151

Source: Own elaboration

LVC sectorial opening

As mentioned before, the final sector disaggregation of this MRIO matrix concerns 35 sectors from which 6 of them are closely related to the LVC. To introduce the details of the latter, we have built structures of production costs and sales of the primary sector of lithium extraction, the industrial sectors that produce lithium-ion batteries, electric cars, installation for utility scale solar electric generation and the power generation from renewable sources.

A first step to characterize those sectors is to estimate the value of the total production (VP). For the primary extraction of lithium, we used the information provided by the Argentinian Ministry of Treasury for quantities and prices. We took the Value Chain Report: Lithium (2018), whose information is consistent with the IDB report (Lopez et al. 2019) concerning the LVC in Latin America. In terms of distribution of the VP between provinces we used the current installed capacity. In this line, it is important to mention that, although Salta has a great potential for lithium production, in the base year there were no operative plants but there were some active projects (exploration fases). As a result, we found that, in 2017, Argentina produced $4.770 millions of current Argentinian pesos and Jujuy produced 55.5% while Catamarca elaborated the rest.

Continuing with lithium extraction, the operative cost structure of this sector was taken from balance sheet information that comes from firms operating in 2017 in the sector. In particular, we analyzed the case of Lithium Americas, the Tres Quebradas Project that belongs to Millennial Lithium and Galaxy Resources. These firms with operative projects in the region allowed us to characterize the main inputs for the production function of the overall sector of lithium extraction. Then, in terms of the sales structure, lithium extraction has two destinies: first, to the international market (exports), which is the main and current destiny of the lithium carbonate (Value Chain Report: Lithium 2018), and second, to the domestic battery cell production (latent production function in the MRIO matrix) as one of its required inputs (thinking in terms of pilot projects). In the latter, to construct the production function of the domestic battery cell sector, we assign a minimum amount of lithium sales to this latent activity. It is important to remark that, for the estimation of the value added and the tax structure of lithium we follow the information provided by Jorratt (2022).

In addition, since the downstream LVC is still not developed in Argentina, we modeled those activities as latent sectors. This means that those sectors are represented in the matrix but without significant

values of their value of production (i.e., we assign a value of production equal to one monetary unit). Nevertheless, the incorporation of these latent activities in the matrix allows us to run further the LVC simulation scenarios without any distortions in the dataset. More precisely, we followed this methodology for the following sectors: Cells, Battery Packs, Electric Vehicles and Utility Scale Solar Plants.

In terms of cost structures, to develop the operative cost of the Battery Cell sector we used data from the Y-TEC project. In the case of Battery Pack, we used information from BIS (2021). For Electric Vehicles we used information from Konig et al. (2021) y Leurent (2015). Finally, for solar panel production we considered data from the World Bank (2021). It is important to mention that all these sectors are connected through the LVC (I.e., Cells buy Lithium, Battery Pack buys Cells and Electric Vehicles and Solar Panel investment buy Battery Packs) even when in the MRIO matrix of the base year these linkages are (almost) absent (i.e., modeled as latent technologies).

Such as for cost structures we also build the latent sales structures for the LVC sectors. We assign intermediate sales of Cells to the Battery Pack activity according to the inputs' requirement that was observed in the cost structures. The rest of the production was assigned to exports. The same procedure was assigned to the Battery Pack sector: Battery Pack has intermediate sales to Electric Vehicles and Solar Technology according to the corresponding input structures and the remaining production goes to exports. Then, for the Electric Vehicles sales, they were assigned as in the regular vehicle industries because the main objective of electromobility is to replace regular mobility means. Finally, for Utility Scale Solar Plant, we assign it to investment since it refers to capital goods mainly directed towards the distributed power generation network and eventually to the development of solar stations that require energy storage.

For non-LVC sectors the structures of costs and sales were already developed in the 2017 Argentina SAM (Chisari et al. 2020) and we mainly took them by considering regional particularities in their economic structures.

Since sectoral disaggregation was done based on survey and non-survey techniques depending on the sector information, the applied method to develop the MRIO matrix is considered a hybrid one and requires a final adjustment for consistency to get the final version (see Appendix 2 for more information).

Table 4 presents the final sectorial opening of 35 sectors (and their codes in the MRIO matrix), where sectors of the LVC are highlighted.

Table 4. Sector disaggregation of the MRIO matrix

№	Sector	Type of Activity	Cod.	Sector aggregates (11)
1	Agricultura, Cattle Rising, silviculture and Fishing	Primary Industry	PRIM	Primary
2	Oil, gas, and Coil Extraction	Primary Industry	OGC	Primary
3	Lithium	Primary Industry	LIT	Lithium
4	Mining	Primary Industry	MIN	Primary
5	Food and Beverage	Industrial Activity	FOBE	Food and Beverage
6	Textile Products	Industrial Activity	TEXT	Industry
7	Wood Products	Industrial Activity	WD	Industry
8	Fuels	Industrial Activity	FUEL	Industry
9	Chemicals	Industrial Activity	CHEM	Industry
10	Plastic and Rubber	Industrial Activity	PLCA	Industry
11	Non-Metallic Minerals	Industrial Activity	NMMIN	Industry
12	Common Metals and Metal Products	Industrial Activity	MET	Industry
13	Machinery and Equipment	Industrial Activity	MACEQ	Industry
14	Vehicles, Trailers and Semi-Trailers	Industrial Activity	VEH	Industry
15	Electric Vehicles	Industrial Activity	ELVEH	Electric Vehicles
16	Transport Equipment	Industrial Activity	TRAEQ	Industry
17	Cells	Industrial Activity	CELL	Cells
18	Battery Pack	Industrial Activity	BAPA	Battery Pack
19	Utility Scale Solar Plant	Industrial Activity	RENMAC	Machinery for Renewable Generation
20	Rest of Industry	Industrial Activity	RESTIND	Industry
21	Non-Thermic Generation of Electricity	Electricity, gas, and Water	NTGEN	Electricity, Gas and Water
22	Thermic Generation of Electricity	Electricity, gas, and Water	TGEN	Electricity, Gas and Water
23	Transport and Distribution of Electricity	Electricity, gas and Water	TRDIEL	Electricity, Gas and Water
24	Gas Distribution	Electricity, gas, and Water	GAS	Electricity, Gas and Water
25	Water and Sanitation	Electricity, gas, and Water	WAT	Electricity, Gas and Water
26	Construction	Services	CONS	Services
27	Commerce	Services	COMER	Services
28	Host Services, Bars and Restaurants	Services	HOTRES	Services
29	Transport	Transport	TRA	Transport
30	Communication	Services	COM	Services
31	Financial Services	Services	FINSE	Services
32	Real State and Business Activities	Services	RSBAC	Services
33	Public Administration and Defense	Services	PUBAD	Services
34	Health and Education	Services	HEEDU	Services
35	Other Services	Services	OTSER	Services

Source: Own elaboration

For the sake of this presentation, in the following sections, we will present the sectoral indicators with a sectoral opening of 11 sectors. The compatibility between the 35 and these 11 sectors' aggregates can be seen in the last column of Table 4.

Sectorial description of MRIO matrix

The current subsection is oriented to present the main features of the MRIO Argentina 2017, and the scope of this presentation lies on the main sectoral aspects and the results for the LVC sectors. As we have mentioned before, we present tables at the 11 sector aggregates but the information for the 35 sectors can be consulted in the Appendix 3.

To begin with the analysis, let us consider the main results for Gross Value Added (GVA) in the regions studied. In this context, Table 5 presents the distribution of value added intra-region and inter-region per sector.

Table 5. Value added per activity (11 sector aggregates) and region (3 provinces and RoA) from the 2017 Argentina MRIO matrix - % and millions of current Argentinian pesos (MM AR$)

Sector	GVA sectoral distribution to each region				GVA geographical distribution to each sector				Total (MM AR$)
	Jujuy	Salta	Catamarca	Rest. Arg	Jujuy	Salta	Catamarca	Rest. Arg	
Primary	7.2%	12.0%	37.8%	9.3%	0.8%	1.9%	4.2%	93.0%	869,971
Lithium	1.5%	0.0%	1.2%	0.0%	55.5%	0.0%	44.4%	0.0%	2,624
Food and Beberage	2.6%	4.8%	2.1%	4.8%	0.6%	1.6%	0.5%	97.4%	426,585
Industry	5.8%	4.2%	4.8%	10.7%	0.6%	0.6%	0.5%	98.3%	939,030
Electric Vehicles	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0
Cells	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0
Battery Pack	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0
Solar Ut. Scale	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0
Electricity, Gas and Water	2.3%	2.5%	1.8%	2.0%	1.2%	1.9%	0.9%	95.9%	184,283
Transport	2.7%	2.3%	1.4%	4.1%	0.8%	0.9%	0.4%	98.0%	360,621
Services	77.9%	74.2%	50.9%	69.1%	1.3%	1.7%	0.8%	96.3%	6,210,246
Total	**99,718**	**139,049**	**97,085**	**8,657,509**	**1.1%**	**1.5%**	**1.1%**	**96.3%**	**8,993,361**

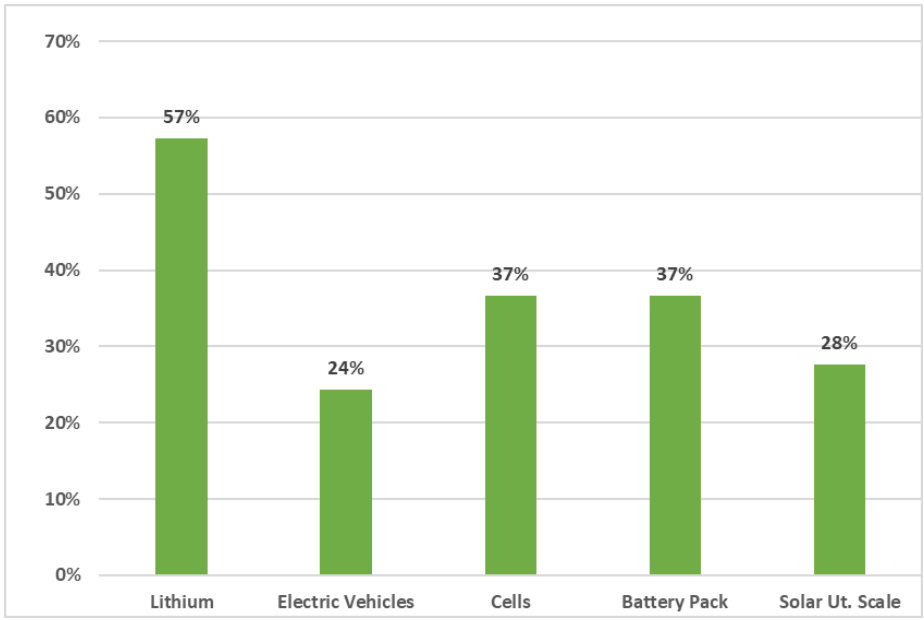
Source: Own elaboration based on the 2017 Argentina MRIO matrix
Note: Table 5 presents two sub-tables: in the first one, the structure (in %) of the GVA generated in each Argentinian province/region, and in the second one, the sectoral GVA generated in each of the four Argentinean regions (in shares).

Paying attention to the Primary sectors and Lithium extraction we can say that these activities have a significant role in explaining VA generation, especially in the case of Catamarca (39% of total VA) which not only non-metallic extraction such as lithium and rhodochrosite but also metals (gold and copper) and rocks (sand and plaster). It is important to remark that Primary activities contain Mining activities which explains these results. Concerning Lithium extraction, we can observe that it explains 1.5% of the value added of Jujuy and 1.2% of Catamarca. It is important to remark that Lithium extraction in Salta does not display any participation in GVA since there are no active projects at the base year.

Looking at the distribution of GVA across regions we can say that as expected the Rest of Argentina concentrates the majority of VA for all the activities. However, concerning Lithium extraction we can see that all its GVA is distributed exclusively between Jujuy (55.5%) and Catamarca (44.4%) in the base year. As mentioned previously, there are no active projects in Salta in 2017. Notice that the downstream LVC sectors were modeled as latent activities and concentrated in the Rest of Argentina. Even when these latent LVC sectors appear in the Rest of Argentina region, it does not imply that in the future they cannot be developed in the provinces. Nevertheless, according to the type of technology installed in each region, and the feasibility of the development of the downstream LVC activities in Argentina, the Rest of Argentina displays a greater comparative advantage.

Digging deeper into the main features of LVC activities, an important indicator to observe is the relationship between value added and value of production. This indicator reflects how much value added would generate an additional monetary unit of production. To do so, Figure 7 presents the VA/VBP indicators for the LVC activities.

Figure 7. Share of value added over value of production for LVC sectors



Source: Own elaboration based on the 2017 Argentina MRIO matrix

As we can see, Lithium extraction is the activity that generates more VA per additional monetary unit of production. Mainly, for each additional unit of production there is an increase of 0.572 monetary units of value added. This is logical since extraction activities are mainly capital oriented. Now, if we go one step forward in the downstream LVC, we can find the Battery Cell production and the Battery Pack production that, in terms of value added are similar but in terms of inputs are different. As a main concern, Battery Cell production demands Lithium Carbonate and the Battery Pack sector demands cells and assembles the battery. Clearly, these are two different processes mainly differentiated by the input structure. Finally, Vehicle Production requires relatively more components (intermediate consumption) than value added for its production (value) in comparison with other LVC activities. These results are consistent with the Argentinian vehicle industry in the base year. A similar consideration must be done with the Utility Scale Solar Panel Plant production, since the construction of these plants requires relatively more inputs than value added.

To continue with the presentation of the results, let us analyze the composition of the demand for the four regions. To do so, Table 6 presents the main features in this regard.

Table 6. Intermediate and final demand per sector per province from the 2017 Argentina MRIO matrix - % and millions of current Argentinian pesos (MMAR$)

Sectors	Jujuy								Total (MM AR$)
	I	CG	X	CD_Jujuy	CD_Salta	CD_Catam.	CD_RA	IS	
Primary	5.5%	0.0%	18.9%	0.0%	0.0%	0.0%	0.1%	75.5%	12,509
Lithium	0.0%	0.0%	95.7%	0.0%	0.0%	0.0%	0.0%	4.3%	2,662
Food and Beberage	6.1%	0.0%	6.5%	14.0%	0.0%	0.0%	57.4%	16.0%	10,394
Industry	12.4%	0.0%	7.0%	3.2%	0.0%	0.0%	17.7%	59.6%	12,016
Electric Vehicles	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0
Cells	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0
Battery Pack	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0
Solar Ut. Scale	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0
Electricity, Gas and Water	0.0%	0.0%	0.0%	8.2%	0.0%	0.0%	33.9%	57.9%	3,711
Transport	0.0%	0.0%	0.0%	1.9%	0.0%	0.0%	31.1%	67.0%	7,101
Services	15.1%	27.0%	0.0%	0.9%	0.0%	0.0%	17.4%	39.6%	132,389
Total	**12.6%**	**19.8%**	**3.6%**	**1.9%**	**0.0%**	**0.0%**	**19.1%**	**43.0%**	**180,783**
Sector	**Salta**								**Total (MM AR$)**
	I	CG	X	CD_Jujuy	CD_Salta	CD_Catam.	CD_RA	IS	
Primary	5.7%	0.0%	28.5%	0.0%	0.0%	0.0%	0.1%	65.7%	27,584
Lithium	0.0%	0.0%	95.5%	0.0%	0.0%	0.0%	0.0%	4.5%	1
Food and Beberage	7.4%	0.0%	9.2%	0.0%	8.0%	0.0%	53.6%	21.7%	24,862
Industry	10.8%	0.0%	8.0%	0.0%	4.0%	0.0%	33.1%	44.1%	19,764
Electric Vehicles	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0
Cells	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0
Battery Pack	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0
Solar Ut. Scale	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0
Electricity, Gas and Water	0.0%	0.0%	0.0%	0.0%	8.0%	0.0%	33.3%	58.6%	5,469
Transport	0.0%	0.0%	0.0%	0.0%	1.6%	0.0%	34.0%	64.4%	8,899
Services	14.3%	22.7%	0.0%	0.0%	1.0%	0.0%	12.2%	49.7%	178,165
Total	**11.7%**	**15.3%**	**4.4%**	**0.0%**	**2.0%**	**0.0%**	**17.6%**	**49.0%**	**264,745**
Sectors	**Catamarca**								**Total (MM AR$)**
	I	CG	X	CD_Jujuy	CD_Salta	CD_Catam.	CD_RA	IS	
Primary	1.1%	0.0%	8.7%	0.0%	0.0%	0.0%	0.1%	90.1%	57,384
Lithium	0.0%	0.0%	95.2%	0.0%	0.0%	0.0%	0.0%	4.8%	2,131
Food and Beberage	2.5%	0.0%	3.5%	0.0%	0.0%	6.9%	78.7%	8.3%	8,407
Industry	7.1%	0.0%	5.4%	0.0%	0.0%	1.7%	49.2%	36.7%	12,595
Electric Vehicles	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0
Cells	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0
Battery Pack	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0
Solar Ut. Scale	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0
Electricity, Gas and Water	0.0%	0.0%	0.0%	0.0%	0.0%	8.9%	30.2%	61.0%	2,468
Transport	0.0%	0.0%	0.0%	0.0%	0.0%	1.5%	53.2%	45.4%	3,862
Services	8.5%	20.4%	0.0%	0.0%	0.0%	0.6%	30.0%	40.5%	76,120
Total	**5.0%**	**9.5%**	**4.9%**	**0.0%**	**0.0%**	**1.0%**	**23.6%**	**56.0%**	**162,967**

Source: Own elaboration
Note: I: Investment; CG: Public Consumption; X: Exports; CD: domestic consumption; IS: intermediate sales.

As Table 6 shows, the main destiny of Lithium Extraction is exports for the three provinces. In the three cases almost 95% of the production goes to exports. Nevertheless, it is important to distinguish that there is a latent intermediate demand from Battery Cells production and a space for intern demand to grow. As we have seen before, this intermediate demand is modeled in the Rest of Argentina where this

technology lies. Now, in terms of the downstream LVC sectors, there is no demand for them since they are in the Rest of Argentina. As mentioned before, this assumption is based on the current location of these firms.

In terms of general results, the province of Salta captures the greatest portion of the lithium demand with 264.745 millions of current Argentinian pesos, followed by Jujuy and finally, Catamarca. Now again, in terms of mining we find a significant contribution of Catamarca for exports and intermediate sales.

Now, let us center our attention on the composition of the consumption basket for the households of each region. To do so, Table 7 describes such composition and presents the total expenditure in consumption done by regional households.

Table 7. Private final consumption basket (households) per region from the 2017 Argentina MRIO matrix - % and millions of current Argentinian pesos (MM AR$)

Sector	Jujuy	Salta	Catamarca	Rest Arg.
Primary	0.1%	0.0%	0.1%	0.1%
Lithium	0.0%	0.0%	0.0%	0.0%
Food and Beber	42.0%	38.1%	35.9%	18.2%
Industry	11.3%	15.3%	13.9%	14.7%
Electric Vehicles	0.0%	0.0%	0.0%	0.0%
Cells	0.0%	0.0%	0.0%	0.0%
Battery Pack	0.0%	0.0%	0.0%	0.0%
Solar Ut. Scale	0.0%	0.0%	0.0%	0.0%
Electricity, Gas	8.9%	8.4%	13.9%	1.8%
Transport	4.0%	2.8%	3.9%	4.5%
Services	33.7%	35.5%	32.2%	60.8%
Total	**3,481**	**5,272**	**1,633**	**6,606,392**

Source: Own elaboration based on the 2017 Argentina MRIO matrix

As it is possible to observe, for all the regions we find that Food and Beverage is the main expenditure for all the households. In this line, households from Jujuy allocate 42% of their consumption in this sector, while households from Salta allocate 38.1% y Catamarca 35.9%. Additionally, services consumption also has a significant participation with 33.7% for Jujuy, 35.5% for Salta and 32.2% for Catamarca. The infrastructure of services plays a major role in the consumption basket of these households. Between Electricity, Gas and Water and Transportation Services households from Jujuy spend 12.9% of their consumption, while households from Salta allocate 11.2% and households from Catamarca 17.8%. The downstream LVC sector has no significant role in the consumption basket for all the households. This is because at the base year such sectors are latent industries which may have impact when they are developed, for instance, in the provision of batteries for solar power generation and electric vehicles.

Now, let us pay attention to the provincial government budget for each province. In this line, Table 8 presents the main results for provincial governments. Note that this line is important since it provides the fundamentals to calibrate regional governments expenditure and regional taxes.

Table 8. Provincial government budgets from the 2017 Argentina MRIO matrix - % and millions of current Argentinian pesos (MM AR$)

Concept	Jujuy	Salta	Catamarca
Government Income	**29,687**	**44,977**	**26,520**
Regional Taxation	12.4%	18.0%	9.6%
Transfers from national Gov.	84.6%	69.0%	75.3%
Non-Tax income	3.0%	13.0%	15.1%
Government Expenditure	**35,092**	**49,837**	**25,936**
Consumption	61.1%	59.8%	57.1%
Investment	8.8%	11.2%	12.9%
Households Transfers	12.8%	5.4%	9.4%
Other rents and transfers	17.2%	23.6%	20.7%
Result	**-5,405**	**-4,860**	**584**

Source: Own elaboration based on the 2017 Argentina MRIO matrix

In this regard, there is a common factor: for those provinces the main income comes from national transfers (i.e., co-participation of tax revenue between provinces); however, regional taxes are not negligible compared to each province's income. Regional taxation is 12.4% of total income in Jujuy, 18% of total income in Salta and 9.6% in Catamarca. Moreover, regional taxation can be split in two lines: 1) on products and 2) on households. For the first one, we find the Gross Income Tax -*Impuesto a los Ingresos Brutos*- which is a provincial tax collected in all Argentinian provinces. Particularly, Jujuy has a share of 80.3% of regional tax collection, for Salta this value is 84.6% and for Catamarca 78.7%. The rest of the tax collection for provincial governments comes from direct taxes over households (i.e., stump duty or real state tax, among others). For this MRIO matrix, we consider taxes collected from products and not from households.

For government expenditures, we find that for every province the main expenditure is in public goods and services with 61.1% for Jujuy, 59.8% for Salta and 57.1% for Catamarca. In every case, public investment is the second category in terms of share in government expenditure. Finally, as it is possible to appreciate, both Jujuy and Salta have a fiscal deficit while Catamarca has a small surplus.

Finally, let us pay attention to the provincial structure of exports. In this regard, Table 9 presents the percentual structure of regional exports.

Table 9. Exports structure per region from the 2017 Argentina MRIO - % and millions of current Argentinian pesos (MM AR$)

Sector	Jujuy	Salta	Catamarca	Rest Arg.
Primary	36.7%	67.0%	62.4%	16.1%
Lithium	39.7%	0.0%	25.4%	0.0%
Food and Beber	10.4%	19.5%	3.7%	30.7%
Industry	13.1%	13.5%	8.5%	27.1%
Electric Vehicles	0.0%	0.0%	0.0%	0.0%
Cells	0.0%	0.0%	0.0%	0.0%
Battery Pack	0.0%	0.0%	0.0%	0.0%
Solar Ut. Scale	0.0%	0.0%	0.0%	0.0%
Electricity, Gas	0.0%	0.0%	0.0%	0.0%
Transport	0.0%	0.0%	0.0%	2.5%
Services	0.0%	0.0%	0.0%	23.7%
Total	**6,423**	**11,734**	**7,987**	**1,180,624**

Source: Own elaboration based on the 2017 Argentina MRIO matrix

Salta concentrates its exports on primary products (67%) and no lithium is exported from this province. Nevertheless, Catamarca and Jujuy are main exporters of extractive sectors. While the export share of lithium is greater in Jujuy (39.7%), other primary products display a larger share of exports in Catamarca (62.4%).

Macro-MRIO

Previous tables of the MRIO matrix detailed at the 11-sectors aggregates can be compacted into a Macro-MRIO matrix presented in Table 10. This Table eeps the scheme of Table 2 and shows the data consistency at regional and national levels.

Table 10. 2017 Argentina Macro MRIO. Millions of current Argentinian pesos

	Jujuy	Salta	Catamarca	Rest Arg.	I	CG	X	CD_J	CD_S	CD_C	CD_RA	Tot. Dem.
Jujuy	19,979	405	251	56,791	22,867	35,775	6,423	3,439	0	0	34,615	**180,547**
Salta	420	32,332	384	96,577	31,094	40,455	11,734	1	5,223	1	46,523	**264,745**
Catamarca	598	858	11,080	78,555	8,227	15,547	7,987	0	0	1,560	38,450	**162,862**
Rest Arg.	40,321	60,463	36,410	6,734,186	1,544,995	1,794,697	1,180,588	40	48	71	6,486,953	**17,878,773**
GVA	85,487	120,324	84,667	7,479,068								
T_J	2,961	-	-	-								
T_S	-	6,843	-	-								
T_C	-	-	2,009	-								
T-S	10,036	14,896	11,272	1,511,379								
T_F	14,231	18,725	12,418	1,178,442								
IMC	6,514	9,899	4,371	743,775								
Tot. Supply	**180,547**	**264,745**	**162,862**	**17,878,773**								

Source: Own elaboration based on the 2017 Argentina MRIO matrix
Note: GVA: gross value added; T_J: taxes Jujuy; T_S: taxes Salta; T_C: taxes Catamarca; T-S: National taxes net of subsidies plus import duties; T_F: factorial Taxes; IMC: imported intermediate consumption; I: Investment; CG: Public Consumption; X: Exports; CD: domestic consumption.

3.1.2. Satellite Account of Employment (SAE)

To characterize the 2017 Argentina SAE consistently with sectors and regions split in the MRIO matrix, we use different heterogeneous sources in terms of economic sectors classification and coverage.

Additionally, to split sectoral employment of the MRIO matrix into occupational categories other data sources were required at microeconomic level for both firms and households.

First, the Generation of Income Account (GIA) by 2017 provides the overall national work force (number of jobs) fully covering the three occupational categories for workers, that is: wage-earners registered (formal jobs) and non-registered (informal jobs) in the Social Security System (SSS) and the non-wage earners that works for their own in an independent way. However, sectoral details for the GIA only reach 17 economic activities. For this reason, we use other data sources to expand the jobs numbers from the 17 activities into the 35 sectors of the MRIO. Firms' declarations of employment information compiled in the Integrated Retirement and Pension System (known in Spanish as SIPA) from the Observatory of Employment and Business Dynamics (known in Spanish as OEDE) of the National Ministry of Labor presents the jobs data of Argentina at 4-digits level of the International Standard Industrial Classification (ISIC) and for each province of the country. Even when this information allows us to match the 35 sectors of the MRIO with the ISIC 4-digit level, SIPA only accounts for formal jobs (wage-earners registered in the SSS) in the private sector, letting aside formal jobs in the public sectors and other types of occupational categories related to informal employment.

Secondly, since informal employment is not negligible in Argentina, we need to complement SIPA information with other microeconomic sources to capture informal jobs (the wage-earners non-registered in the SSS and the non-wage earners) at the 35 sectors and the 4 regions of the MRIO matrix. Accordingly, we will have a comprehensive picture of employment for this project. Thus, we use the Permanent Household Survey (known EPH in Spanish) to also monitor the informal employment at the sector and region levels. The EPH is a national survey that allows us to know sociodemographic and economic characteristics for the regional population, and, for our interest, it allows calculating the share of employment by occupational categories at sector and province levels. In terms of sectoral details, EPH data is presented at the Mercosur Classification of Economic Activities[4] that allows matching with the 35 sectors of the MRIO matrix. However, the EPH has partial coverage of the national territory and its population, a situation that particularly affects the economic activities that are not predominantly urban, such as agriculture, mining, and fishing. To expand the population coverage of the EPH and to improve our estimations of the SAE, we take the Annual Urban Households Survey (known as EAHU in Spanish)[5] since it allows increasing the urban population sample in 2 thousand observations approximately at regional level. Improving jobs estimations in urban sectors of each region allows us to simultaneously refine jobs estimations for non-urban sectors (agriculture, mining, and fishing) keeping consistency with the overall national employment registered in the GIA for 2017. Consistency between the GIA information and the households survey data is checked for the 35 sectors and the 4 regions of the MRIO matrix, but also for the three occupational categories that allow isolate formal from informal jobs.

It is important to highlight that to accomplish this data treatment it is necessary to prepare tables of sectoral correspondences since each data source has its own sectoral disaggregation. For that purpose, we have harmonized the product structure of EPH-EAHU and SIPA-OEDE datasets to match with the 35 sectors of the MRIO matrix and the 17 activities of the GIA.

Finally, the lithium sector's employment was calculated based on lithium firms' information collected for this project. Allkem and Lithium Americas enterprises were relevant for building not only employment in Jujuy´s province but also in the Rest of Argentina. In the case of Catamarca, the

[4] For see the details about Mercosur Classification of Economic Activities: https://www.indec.gob.ar/ftp/cuadros/menusuperior/eph/caes_mercosur_1.0.pdf.

[5] The compilation of data sets for the EAHU took the period from 2010 and 2014. Although the EAHU does not present data available for 2017, we use the coefficient for monitoring the employment in sectors that EPH cannot cover correctly.

employment information of Livent enterprise was taken for the lithium sector. No employment was allocated to the lithium sector in Salta since none of lithium projects in this province was operative in 2017.

Summarizing the process applied to build the SAE consistent with the MRIO matrix, we can say that total jobs at the national have been taken from the GIA that keep consistency with the National Account information which is the basis of the MRIO matrix. Then, shares to split the GIA data into the 35 sectors, the 4 regions and the 3 occupational categories were estimated based on SIPA-OEDE for formal jobs and EPH and EAHU for informal jobs (wage-earners non-registered in the SSS and independent workers). This treatment keeps consistency between micro and macro data and thus, between employment (jobs) and labor value-added at sector and region levels from the MRIO matrix.

Table 11 presents the structure of employment at sectoral level for each province/region and at the sectoral level across regions. Jobs in the lithium sector in Catamarca and Jujuy are less than 0.5% of the total of those provinces, but since this activity is only concentrated in these regions, they share the overall employment in the lithium extraction sector. Other sectors of the LVC are latent activities in the MRIO so they do not display any job in the base year.

Table 11. 2017 Argentina SAE: Total employment (jobs) by the MRIO matrix sectors and regions

Sector	Sectoral distribution of jobs in each region				Geographical distribution of job into each sector				Total (jobs)
	Catamarca	Jujuy	Salta	Rest. Arg	Catamarca	Jujuy	Salta	Rest. Arg	
Primary	7.4%	9.3%	10.3%	7.1%	0.8%	1.7%	3.5%	93.9%	1,470,301
Lthium	0.2%	0.1%	0.0%	0.0%	52.6%	47.4%	0.0%	0.0%	565
Food and Beberage	1.9%	2.1%	3.5%	3.3%	0.5%	0.9%	2.6%	96.0%	665,849
Industry	4.9%	4.2%	5.3%	8.4%	0.5%	0.7%	1.6%	97.2%	1,668,135
Electric Vehicles	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0
Cells	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0
Battery Pack	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0
Machinery for Renewable Generation	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0
Electricity, Gas and Water	0.8%	0.6%	0.7%	0.6%	1.1%	1.2%	2.6%	95.1%	125,780
Transport	2.3%	3.1%	3.4%	5.0%	0.4%	0.9%	1.7%	97.1%	1,005,958
Services	82.5%	80.7%	76.8%	75.6%	0.9%	1.4%	2.5%	95.2%	15,408,078
Total	**168,196**	**276,191**	**494,913**	**19,405,366**	**0.8%**	**1.4%**	**2.4%**	**95.4%**	**20,344,666**

Source: Own elaboration based on GIA 2017; SIPA-OEDE 2017; EPH 2017; EAHU 2014

The complete SAE for the MRIO matrix is presented in Appendix 4.

3.2. MRIO model for Lithium simulations

In its most basic form, an input-output model is a linear system of *n* equations with *n* unknowns whose main purpose is to analyze changes in demand and inter-industry relationships (Miller and Blair 2009). Each of these equations describes the distribution of a product or activity throughout the economy. These models are recognized and widely applied tools throughout economic theory to estimate the direct and indirect effects of an exogenous shock or change in economic policy. The linear nature of this system of equations makes the matrix representation straightforward and facilitates the resolution of the exercise. This model assumes that demand shocks do not affect prices and that there are no supply constraints (infinite productive capacity) (Miller & Blair 2009).

The model is built based on information provided by an IO matrix that contains information on inter-sectoral flows, the structure of final demand and the value added of the different sectors that make up the matrix. As mentioned before, the underlying assumption behind these matrices is the idea of *circular flow*, i.e., that all the outflows of one agent are the income of another. For example, if the

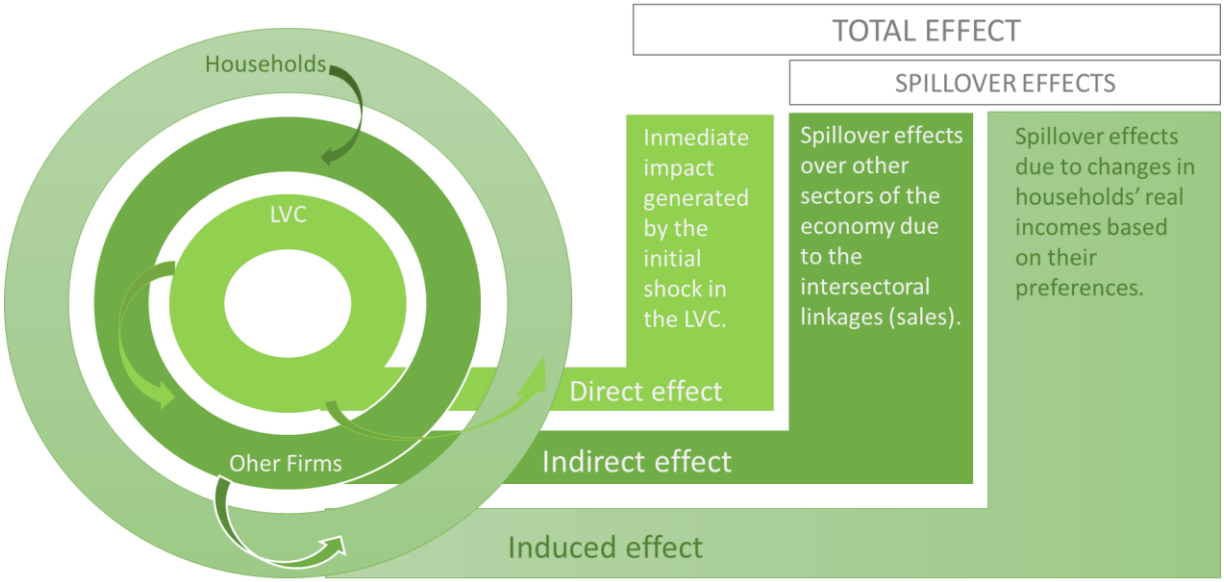
battery sector sells lithium-ion batteries to the automotive sector for electric vehicles, it implies an *inflow* for the former and an *outflow* for the latter. In this way, a consistent matrix structure is obtained that complies with the basic budget conditions (everything produced is demanded). For the MRIO model to be used in this project, we required a MRIO matrix with a proper and detailed representation of all activities in the lithium value chain in all regions as presented before.

Furthermore, once the MRIO model is calibrated with the base MRIO matrix and its SAE, we can undertake a first multipliers' analysis explaining the current and potential forward and backward linkages of the lithium sector in each region and at the national level. Then, based on the designed prospective scenarios for the LVC, we will be able to simulate them by identifying different components of the scenario (investment, production, final demand) at different horizons (2022, 2025 and 2030 - see Section 4 below). We will decompose the total impact into direct, indirect, and induced impacts once the model has incorporated the household demand or other components of the final demand as endogenous.

For each prospective scenario (described in Section 4 below), we consider investment and production shocks of the LVC. For instance, the impact of investments in new lithium extraction projects in particular regions and/or for a lithium-ion batteries factory will be represented as exogenous shocks based on structures of investment vectors. Capital expenditure (CAPEX) information about current and potential investment projects will be the source of data to build an average structure to shock the model. In this sense, the MRIO analysis of this shock will allow us to observe what happens to the other sectors and regions of the economy because of a particular change in one of them. Other types of shock that will be run under the scenario explain the impact on production due to greater or a new demand. An example of this scenario could be the increase in the demand of lithium-ion batteries for electromobility and/or storage of renewable energies. More details about the shocks in each scenario are described in Section 4.

As mentioned above, results of these scenarios will be presented and analyzed at national, regional (the three provinces rich in lithium resource) and sectoral (the LVC and other sectors) levels, being the main variables value-added, production, employment (jobs) and exports. In this sense, the total outcomes of simulation will be decomposed into three types of effect: *direct effect* related to the specific shock, *indirect effect* which is related to the impact in the other economic sectors of the MRIO matrix, and *induced effect* that is provided through the household consumption vector in the MRIO matrix (Figure 8). These impacts allow us to enrich the analysis to see the main sources of influence.

Figure 8. Decomposition of LVC simulations effects



Source: Own elaboration

4. Design of lithium value chain scenarios

The third specific objective of the study is to quantify the potential economic impact of developing the lithium value chain in Argentina, focusing on the regional impact in the three provinces rich in this natural resource: Catamarca, Jujuy, and Salta. Within this framework, an essential task of the study is to design prospective scenarios to evaluate the potential socio-economic effects of the LVC development in Argentina in the near future (horizon 2030).

The study does not assign probabilities of occurrence to the modeled scenarios. Rather, it aims to evaluate the opportunities that plausible energy transition trajectories processes offer for the development of lithium-related activities. This exercise may provide useful insights informing policy design and decision-making processes.

We built the scenarios taking into consideration the whole range of products included in Table 12, which encompass the segments of the lithium-ion battery value chain described in Section 2. We estimated the volume of manufacturing output and the market size of electromobility and renewable energies in Argentina based on scenarios proposed in official documents (*Lineamientos para un Plan de Transición Energética al 2030*) and the study of global production networks (Obaya & Céspedes 2021) (see details below). We adjusted and validated the scenarios based on information collected from interviews with experts.

Table 12. Segments of the value chain considered to build scenario

Segment	Upstream	Midstream	Downstream		
Industry	Lithium compounds	Lithium-ion batteries		Electromobility	Renewable energies
Products	Lithium carbonate	Cathodes	Battery cells and packs	Electric vehicles	Solar and wind power

Source: Own elaboration

Based on this analysis, we decided to exclude from our scenarios the industrial-scale production of some battery electrodes (cathodes) and cells. As discussed below, the production of these goods has been modeled at a low scale, as part of a R&D initiative led by Y-TEC and the National University of La Plata. This decision is not without controversy, in particular in the case of cathodes, since this product is a direct source of demand for the lithium compounds produced in Argentina (i.e., lithium carbonate). However, we have not identified investment projects oriented to produce cathodes and cells in Argentina during the period under analysis.

The reluctance of investors to set up manufacturing operations in the country might be explained by a variety of reasons. Whereas the market of lithium compounds (i.e., upstream) is highly internationalized, with strong trade flows from resource rich countries to processing sites, midstream and downstream segments are inherently regionalized around large electromobility markets. In other words, the battery supply chain (in particular, the production of cells) tends to develop within regions of high demand for electric vehicles (Jones et al. 2021). The South American markets of electromobility and renewable energies are relatively small compared to those of Asia, Europe, and North America. Mexico is the only country in the Latin American region which has been able to attract investment in the cathode segment and, more in general, battery cells (Fact.MR 2019). This is explained by the close integration of the country to North American automotive production networks.

Furthermore, in the case of cathodes, it is worth stressing that lithium only accounts for a small share of its composition (around 11%, depending on the cathode technology). The lithium triangle countries

do not produce other materials –which, in some cases, are also critical– used as input in the production of cathodes, such as class 1 nickel, cobalt or manganese. These materials would need to be imported at great expense, most likely from Asia (Jones et al. 2021).

It should also be noted that the impact of lithium prices in midstream and downstream segments is limited. This makes it difficult to build competitive advantages based on cost-competitive raw materials. This is illustrated by the recent failure of Chile's policy to attract cathode producers based on the local supply of lithium hydroxide at a preferential price (Poveda 2020).

As pointed out above, for each industry we built a conservative, a moderate and an optimistic scenario, based on assumptions that will be specified below. Each scenario indicates different combinations of situations regarding the four groups of activities: Lithium production, Battery production, Electromobility and Renewable energies. Below, we explain the rationale, assumptions and the specific sources of information and data used for the development of each scenario. To develop the scenarios, we mainly relied on secondary sources detailed in Table 13. Next, based on previous data we build the scenarios having three horizons: 2022, 2025 and 2030.

Table 13. Data sources for LVC sectors for scenarios' design

Activity	Item	Source
Lithium compounds	Production prospects	Firms' reports and announcements Interviews with specialists
	Capital expenditure (CAPEX)	Firms' reports and feasibility studies
	Operating expenses (OPEX)	
Lithium-ion batteries	Production prospects	Interviews with specialists
	Capital expenditure (CAPEX)	Interviews with specialists Specialized literature
	Operating expenses (OPEX)	Consultancy reports
Electromobility	Domestic market prospects	Lineamientos para un Plan de Transición Energética al 2030 (Secretary of Energy, Argentina)
	Capital expenditure (CAPEX)	Interviews with specialists
	Operating expenses (OPEX)	Specialized literature and reports
Renewable energies	Production prospects	Lineamientos para un Plan de Transición Energética al 2030 (Secretary of Energy, Argentina)
	Capital expenditure (CAPEX)	Interviews with specialists
	Operating expenses (OPEX)	Specialized literature and reports

Source: Own elaboration

4.1. Lithium extraction and compounds production

The development of future scenarios on lithium production is very challenging. Lithium projects develop in different stages (Figure 9) that, in the case of brines deposits, extend over a period that ranges between 7 and 10 years (Lopez et al 2019; Flexer et al 2018). The whole process is affected by great uncertainty caused by different factors, including macroeconomic and institutional uncertainty, specific technical challenges raised by the exploitation of brines, price volatility, access to funding and conflicts with local communities.

Figure 9. Stages of development of a lithium project

Source: Own elaboration

To build the scenarios we took as a reference the list of projects reported by the Secretary of Mining in October 2021, which reports projects that have gone beyond the initial exploration (Table 14). We analyzed in detail the 12 projects that reached at least the stage of preliminary economic assessment.

Table 14. List of advanced projects

Project	Company	Province	Stage
Mina Fenix	Livent Corporation	Catamarca	Production
Salar de Olaroz	Sales de Jujuy (Allkems, Toyota Tsusho, JEMSE)	Jujuy	Production
Cauchari-Olaroz	Minera Exar (Lithium Americas, Ganfeng, JEMSE)	Jujuy	Construction
Pastos Grandes	Lithium Americas	Salta	Feasibility
Sal de Oro	Posco	Salta	Advanced exploration
Sal de Vida	Allkems	Catamarca	Feasibility
Rincon Lithium Project	Argosy Minerals	Salta	Preliminary economic assessment
Salar del Rincón	Rincon Lithium	Salta	Feasibility
Tres Quebradas	Neo Lithium	Catamarca	Pre-feasibility
Centenario Ratones	Eramet	Salta	Feasibility
Mariana	Litio Minera Argentina, International Lithium Corp.	Salta	Preliminary economic assessment
Sal de los Ángeles	Tibet Summit	Salta	Preliminary economic assessment
Kachi	Lake Resources	Catamarca	Pre-feasibility
Cauchari	Allkems	Jujuy	Pre-feasibility
PPG	Plus Petrol	Salta	Preliminary economic assessment
Salar del Hombre Muerto Norte	NRG Metals	Salta	Preliminary economic assessment
Salar del Hombre Muerto Oeste	Galan Lithium Ltd.	Catamarca	Preliminary economic assessment
Candelas	Galan Lithium Ltd.	Catamarca	Advanced exploration
Pular	Pepinninni Lithium Ltd.	Salta	Advanced exploration
Rincón	Pepinninni Lithium Ltd.	Salta	Advanced exploration
Río Grande	Plus Petrol	Salta	Advanced exploration
Gallego	Everlight Resources	Salta	Advanced exploration
Salinas Grandes	Plus Petrol	Jujuy	Advanced exploration

Source: Secretaría de Minería 2021

The conservative scenario corresponds to the estimate made by Schteingart and Rajzman (2021) (Table 15). The moderate and optimistic scenarios are based on own estimates. To forecast the evolution and the production capacity of the project we took into consideration different factors, including the current stage of the project, its financial situation, and the announcements made to investors. We assumed that the construction process extends by a period of two years, whereas the ramp-up of production takes three years. Tables detailing the evolution of projects in conservative, moderate and optimistic scenarios are included in Appendix 5.

In conservative scenarios, we do not allow the simultaneous development of different projects controlled by the same firms (e.g., Ganfeng in Mariana and Lithium Americas in *Pastos Grandes*). In other words, firms cannot begin to invest in one operation if they have not completed the ramp-up of production in another active operation. In the same vein, in conservative scenarios, we do not include the stage 3 of developed projects such as *Hombre Muerto* (Livent), or *Olaroz* (Allkem, Toyota Tsusho, JEMSE). These restrictions are lifted in moderate and optimistic scenarios.

Table 15. Summary of lithium production assumptions under the three prospective scenarios

Year	CONSERVATIVE	MODERATE	OPTIMISTIC
2022	Production: 37,000 tonc LCE in 2022 (Documento CEP XXI Schteingart y Rajzman)	Production: 42,800 tons LCE in 2022 (own estimate)	Production: 47,966 tons LCE in 2022 (own estimate)
	Price USD 15,000 / ton LCE	Price USD 15,000 / ton LCE	Price USD 15,000 / ton LCE
	Investment: 14.8 MM USD / '000 tons LCE	Investment: 14.8 MM USD / '000 tons LCE	Investment: 14.8 MM USD / '000 tons LCE
	1 new project under development	5 new projects under development.	5 new projects under development.
2025	Production: 107,000 tonc LCE in 2025 (Documento CEP XXI Schteingart y Rajzman)	Production: 165,366 tons LCE in 2025 (own estimate)	Production: 209,665 tons LCE in 2025 (own estimate)
	Price: USD 18,000 / ton LCE in 2025	Price: USD 18,000 / ton LCE in 2025	Price: USD 18,000 / ton LCE in 2025
	Investment: 14.8 MM USD / '000 tons LCE	Investment: 14.8 MM USD / '000 tons LCE	Investment: 14.8 MM USD / '000 tons LCE
	Investment: 2 new projects under development between 2022 and 2025.	Investment: 9 new projects under development between 2022 and 2025.	Investment: 11 new projects under development between 2022 and 2025.
2030	Production: 303,000 tons LCE in 2030; Price: YYY	Production: 320,866 tons LCE in 2030; Price: YYY	Production: 463,000 tons LCE in 2030; Price:YYY
	Price: USD 18,000 / ton LCE in 2030	Price: USD 18,000 / ton LCE in 2030	Price: USD 18,000 / ton LCE in 2030
	Investment: 14.8 MM USD / '000 tons LCE	Investment: 14.8 MM USD / '000 tons LCE	Investment: 14.8 MM USD / '000 tons LCE
	7 new projects under development between 2025 and 2030.	8 new projects under development between 2025 and 2030.	7 new projects under development between 2025 and 2030.

Source: Own elaboration
Note: LCE = lithium carbonate equivalent.

The CAPEX and operating expenses OPEX of the different activities are specific to each project. They are affected by factors such as the scale of the operation, the characteristics of the products, the capabilities of the firm and the ecosystem in which the firm operates. However, as we do not have detailed information of each project, we estimated the expenses based on breakdown cost information of the three following projects (Appendix 1):

- *Cauchari Olaroz*, operated by Lithium Americas, Ganfeng and JEMSE.
- *Sal de Vida*, operated by Allkem.
- *Tres Quebradas*, operated by Neo Lithium.

The average CAPEX of these projects is estimated at US$ 14,818 per metric ton of lithium carbonate equivalent of installed capacity. As for the OPEX, the average is estimated at US$ 3,300 per metric ton LCE, which positions these projects among the most cost-competitive at global level (Table 15).

Table 15. Operational expenses (US$ per metric ton) and production capacity (thousand metric tons, LCE) of current brines operations

Plant	OPEX (US$ per ton)	Production capacity (thousand tons per year)
Brines operations in China		
Zhabuye	5,252	2
Qarhan	6,097	10
East Tajinar	7,357	10
West Tajinar	5,739	7
Brines operations in South America		
Albemarle Chile	3,639	42
SQM Chile	3,450	60
Hombre Muerto	4,101	15
Salar de Olaroz	4,390	16

Source: Jones et al 2021

4.1.1. Lithium-ion batteries

The chain of production of lithium-ion batteries can be divided in three main stages: electrodes, cells, and packs (Figure 1, in Section 2 of this appendix). For the reasons discussed above, we have not considered in our scenarios the production of electrodes and cells at industrial scale.

We included the production of cathode materials and cells in at low scale project announced by Y-TEC and the National University of La Plata in Argentina. A turnkey plant to produce battery cells has been imported from China with an estimated production capacity of 13.5 MWh/year (in the three scenarios this production volume would be reached in 2025), employing around 20 people per shift. Initially, the plant will operate in one shift with an estimated production capacity of 5MWh/year (in an optimistic scenario this stage will be reached in 2022).

The main objective of the plant is to contribute to "open the black box" of technology, thus improving the local knowledge about the manufacturing process of battery cells. At the start, cathode material will be imported. However, the project contemplates the possibility that Y-tec produces LFP cathode material (in an optimistic scenario this will be reached in 2025). The leaders of the project also evaluate the possibility of producing the electrolyte locally, since a low scale project like this finds it difficult to import this component. It is worth pointing out that, except for the situation when LFP material is produced in the country, the project would import lithium carbonate. Therefore, the project does not establish any linkage with the domestic lithium industry. Even in the case when LFP is manufactured locally, the volume of demand for lithium compounds is negligible.

The assembly of the manufactured cells in battery packs will be outsourced to domestic companies. As for the final market, an agreement was signed with the Ministry of Defense, which will be the main client of the joint venture. Batteries will be mainly used to store energy in isolated locations depending on this institution.

In our moderate (2030) and optimistic (2025-2030) scenarios we also contemplate the establishment of a battery cell assembly plant (i.e., a battery pack plant). This possibility would be conditioned by the evolution of the electromobility market, given the trend of the industry to agglomerate investment around consumption markets (see discussion above). The plant would mainly serve the growing demand that originates from the expansion of the domestic electromobility industry. Accordingly, the production capacity of the plant is estimated based on a 30kwh battery, which is the one that, according to our assumptions, will be used by the passenger cars manufactured in Argentina (see Electromobility below). In the optimistic scenario 2030, we also contemplate the possibility of exporting the surplus of battery packs.

The battery pack plant will import the cells and most components. This entails that the plant does not establish any linkage with the domestic lithium production. Apart from local labor, value-added opportunities would be mainly concentrated in the battery management system. Currently, the country has a few firms specialized in pack assembling with low scale manufacturing capacity. The OPEX of this project will be estimated based on reports by consultancy firms (Y-Tech) and interviews with specialists.

Table 16. Summary of assumptions under the three scenarios to lithium-ion battery production

Year	CONSERVATIVE	MODERATE	OPTIMISTIC
2022	Cells: no production	Cells: no production	Y-TEC-La Plata: Cells production: 5MWh/year ; Cell price: USD 532 KWh (source: interview with specialist)
	Battery packs: no local production	Battery packs: no local production	Battery packs: no local production
2025	Y-TEC-La Plata: Cells production: 13,5 MHh/year ; Cell price: 346 KWh (source: interview with specialist; price: own estimate)	Y-TEC-La Plata: Cells production: 13,5 MHh/year ; Cell price: 346 KWh (source: interview with specialist; price: own estimate)	Y-TEC-La Plata: Cells production: 13,5 MHh/year with local production of LFP cathodes ; Cell price: 346 KWh (source: interview with specialist)
	No local production of battery packs	No local production of battery packs	Battery assembly (packs): Total production 1,120 MWh per year ; Price of the pack: USD 27 KHw
	Production remains limited to the joint project by Y-TEC and INIFTA-CONICET	Production remains limited to the joint project by Y-TEC and INIFTA-CONICET	Production of batteries by Y-TEC and INIFTA-CONICET with local production of LFP cathodes
			A battery pack assembly plant is installed to serve the domestic demand for electromobility.
2030	Y-TEC-La Plata: Cells production: 13,5 MHh/year with local production of LFP cathodes ; Cell price: 190 KWh (source: interview with specialist; price own estimate)	Y-TEC-La Plata: Cells production: 13,5 MHh/year with local production of LFP cathodes ; Cell price: 190 KWh (source: interview with specialist; price own estimate)	Y-TEC-La Plata: Cells production: 13,5 MHh/year with local production of LFP cathodes ; Cell price: 190 KWh (source: interview with specialist; price own estimate)
	No local production	Battery packs production: 1,434 Mwhper year ; Battery price: 14,95/kWh	Battery packs production: 5,000 Mwhper year ; Domestic demand 3,587 MWh ; Exports 1,412 MWh ; Battery price: 14,95/kWh
	Production of batteries by Y-TEC and INIFTA-CONICET with local production of LFP cathodes	Production of batteries by Y-TEC and INIFTA-CONICET with local production of LFP cathodes	Production of batteries by Y-TEC and INIFTA-CONICET with local production of LFP cathodes
		A battery pack assembly plant serves the domestic demand for electromobility.	A battery pack assembly plant serves the domestic demand for electromobility and exports the surplus

Source: Own elaboration

4.1.2. Electromobility

In relation to the situation of the electromobility market in Argentina, we elaborated three scenarios. In the conservative one, we contemplate no domestic production of electric vehicles. The moderate and optimistic scenarios are based on the estimates by the Secretary of Energy included in the document *Lineamientos para un Plan de Transición Energética al 2030*. The document offers two scenarios. The first one corresponds to the trend scenario, based on current policies (moderate

scenario in our study). In this case, the share of electric vehicles sales would be 8% of total sales of passenger vehicles and light utility vehicles in 2030. We estimated that this share would be of 2% in 2025.[6] The second estimate in the document corresponds to the electrification scenario, which assumes higher levels of electric mobility and of substitution of other fuels by electricity (optimistic scenario in our study). In this case, the share of sales of electric passenger cars and light utility vehicles over total vehicle sales reaches 20% in 2030. Based on this figure, we estimated a share of 6% in 2025.[7] The assumptions on the sales volume of vehicles in each scenario is based on the forecast elaborated in the frame of the *Plan de Acción Nacional de Transporte y Cambio Climático (PANTyCC)*.

The three scenarios are below the projections estimated by the International Energy Agency (Global EV Outlook 2021*).* As shown in Table 17, for the category "Rest of the World", the Agency estimates, for 2030, a share of EV sales over total sales of 17.3% and 36%, in the "stated policies" and "sustainable scenarios", respectively. This group of countries includes a wide range of economies with different policy approaches. Some of them, such as Canada, Israel, and Korea, have adopted policies and other measures to support vehicle electrification and have net-zero emission pledges.

Table 17. Projections of share of EV sales in total vehicle sales

Country/Region	Year	Stated Policies Scenario	Sustainable Development Scenario
China	2025	20,1%	35,00%
	2030	33,8%	42,40%
Europe	2025	19,2%	32,87%
	2030	35,8%	77,50%
India	2025	6,5%	8,96%
	2030	10,9%	29,20%
USA	2025	77,7%	14,40%
	2030	15,7%	49,57%
Resto of the World	2025	10,3%	18,80%
	2030	17,3%	36,00%

Source: Global EV Outlook 2021

In our moderate and optimistic scenarios, we assumed that the domestic demand was served by local production of vehicles. The price of the manufactured vehicles was estimated at US$ 12,000, which corresponds to a low-end electric vehicle. We also assumed that the manufactured vehicles would use a battery of 30 kwh.

[6] The document does not provide an estimate for 2025. We calculated it based on the figures published in other report by the Secretary of Energy in 2019 (Escenarios Energéticos 2030). In that document the share of electric vehicle sales over total vehicle sales quadrupled between 2025 and 2030.

[7] Again, we based the estimate for 2025 in Escenarios Energéticos 2030. In that document, the estimate for 2030 in the electrification scenario was 3,33 times higher than in 2025.

Table 18. Summary of assumptions under the three scenarios about electromobility

Year	CONSERVATIVE	MODERATE	OPTIMISTIC
2022	No local production	No local production	No local production
	Domestic market of EV remains at 1,5% (hybrid+electric)	Domestic market of EV remains at 1,5% (hybrid+electric)	Domestic market of EV remains at 1,5% (hybrid+electric)
2025	No local production	No local production	Electric vehicles production: 37,334 units /year ; Price: 12,000 USD
	Remains at 1,5%	Penetration rate of electromobility in Argentina is estimated at 2% (passenger and light utility vehicles) Source: Lineamientos para un Plan de Transición Energética al 2030	Penetration rate of electromobility in Argentina is estimated at 6% (passenger and light utility vehicles). Lineamientos para un Plan de Transición Energética al 2030
	The domestic demand of electric vehicles is met with imports.	The domestic demand of electric vehicles is met with imports.	The domestic demand of electric vehicles is met with local production.
2030	No local production	Electric vehicles production: 47,830 units /year ; Price: USD 12,000	Electric vehicles production: 119,576 units /year ; Price: 12,000
	2% (base moderate 2025)	Penetration rate of electromobility in Argentina is estimated at 8% (passenger and light utility vehicles) Source: Lineamientos para un Plan de Transición Energética al 2030	Penetration rate of electromobility in Argentina is estimated at 20% (passenger and light utility vehicles). Lineamientos para un Plan de Transición Energética al 2030
	The domestic demand of electric vehicles is met with imports.	The domestic demand of electric vehicles is met with imports.	The domestic demand of electric vehicles is met with local production: battery cells and packs are manufactured locally.

Source: Own elaboration

4.1.3. Renewable energies

The scenarios corresponding to the evolution of energy originated in renewable sources are based on the official publication *Plan de Acción Nacional de Energía y Cambio Climático* (2017), as suggested by the World Bank staff (Florencia Balastro). The figures were adjusted with interviews with specialists on renewable energies, particularly for the design of the optimistic scenario.

Basically, the design of the renewable energy scenarios (i.e., greater supply of electricity generated by renewable sources and distributed power generation) meet the energy and climate change objectives for 2030. In this sense, the three scenarios in 2022 assume no increase in renewable energy participation in total energy remaining all conservative for the current year. However, in 2025 we assume a change in the composition of the electric power generation, by increasing the participation of renewable sources in 20% and decreasing the participation of thermal electricity proportionally. This assumption by 2025 is kept under the three scenarios, conventional, moderate, and optimistic. By 2030 we can distinguish differences in the target of renewable sources penetration. Under the conservative scenario the percentage of renewable electricity reaches 25%, while under the moderate and optimistic scenario it even increases up to 27% and 30%, respectively. The latter was publicly declared as an ambitious target by policymakers of the Environmental Ministry and Energy Secretary during 2020-2021.

These assumptions are based on the Energy National Plan for Climate Change and supported by a legal framework (i.e., law No. 27.191/2016 of renewable energies; law No. 27.424/2017 of distributed power generation) and national programs (e.g., the different rounds of the *Renovar* program). Even when the accomplishment of these targets by 2025 and 2030 depend on the investment in infrastructure on solar and wind plants and on the electricity distribution network, these investment shocks were not simulated under these LVC scenarios to not "dirty" the results of the lithium investments, and because remains out of the scope of this project. Nevertheless, CAPEX of the *Renovar* projects are available from reports and interviews with specialists.

Table 19. Summary of assumptions under the three scenarios about renewable energies

Year	CONSERVATIVE	MODERATE	OPTIMISTIC
2022	No change	No change	No change
2025	20% of power generation based on renewable souces (solar and wind)	20% of power generation based on renewable souces (solar and wind)	20% of power generation based on renewable souces (solar and wind)
2030	25% of power generation based on renewable souces (solar and wind)	27% of power generation based on renewable souces (solar and wind)	30% of power generation based on renewable souces (solar and wind)

Source: Own elaboration based on Gabinete Nacional de Cambio Climático - "Plan de Acción Nacional de Energía y Cambio Climático" 2017

5. Analysis of the development of LVC simulations

In order to present simulation results of the three LVC scenarios (conservative, moderate and optimistic) at the three temporal horizons (2022, 2025, 2030). Results of LVC simulations are consistent with the increasing ambition of the three design scenarios and the targets at different temporal horizons (i.e., impacts are greater under the optimistic scenario than the conservative one at 2022, 2025 and 2030). We summarize the impacts at national, regional, and sectoral levels for main socioeconomic variables (value of production, GDP, employment, tax revenue and exports) and production and employment multipliers.

As described in the design of scenarios, the development of the LVC can be split into two origins of shocks, the first one is due to the new investment in the lithium extraction sector, and the second one, due to the production phase when the new investment becomes operative in the upstream sector. Regarding the shocks on cells and battery packs, they are concerned exclusively for the production phase.

For a good reading of the next tables, it is important to note that results concerning the investment phase in lithium plants will be presented in a cumulative way for the comprehensive period (at least 2 years), i.e., jobs generated during the investment period. For results about the production phases, they are shown yearly (i.e., jobs generated in lithium production in the year 2030). Thus, the difference between results from the investment shock and the production shock is that in the former jobs are temporary since they are linked to precise duration of the investment projects while jobs generated in production when capacity is built could be considered as permanent and yearly.

Results will be presented in the following way. First, in subsection 5.1, we start describing the results of the three scenarios in 2022. Since we are already in this year, the most realistic one by the end of 2022 could be the conservative one. Thus, for the presentation of results under 2025 and 2030 in subsection 5.2, we consider additional gains compared to this conservative scenario in 2022 as base. Moreover, results for 2025 and 2030 are also presented in terms of percentage change compared to a dynamic baseline in which the assumption is a business as usual from now and assuming a 1.25% yearly increase of GDP until 2030.

5.1. Conservative vs. moderate & optimistic LVC scenarios impacts in 2022

For the three LVC scenarios in 2022 we assume that the required investments in new lithium plants have been done in previous years by allowing for a greater production capacity that becomes operative in 2022. Thus, we present the results of the lithium production shocks in 2022 under the three scenarios and for the optimistic one we also add the impact of cell production.

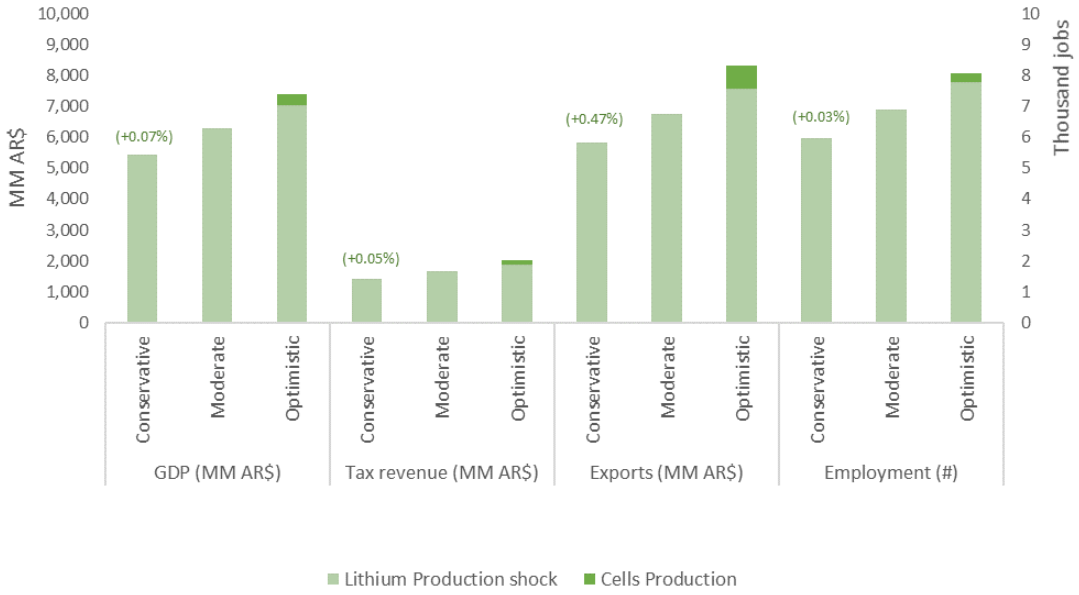
Among the three LVC scenarios in 2022 we can consider the conservative as the most realistic one, since the other two required greater lithium production capacity whose investments have not been started yet (and we are already starting the 2022). In this sense, we consider the conservative scenario in 2022 as a reference one to compare the results of other scenarios for the same year and for medium- and long-term results of the three LVC scenarios in the next subsection.

Figure 10 presents the impact on main macroeconomic variables. According to the conservative lithium production shock Argentinean GDP would increase in 5,449 MM AR$ compared to 2017 GDP in the MRIO matrix. This increase represents 0.07% of 2022 GDP in the BAU baseline. Exports increase (5,846 MM AR$ compared to 2017) corresponds to lithium export increase which in terms

of 2022 BAU exports represents 0.47%. We must remember that lithium production in 2022 is for exports and no linkage appears with the rest of the productive domestic LVC. Nevertheless, the increase in lithium production for export allows increasing tax revenue, GDP, and employment at the national level. Tax revenue and employment at national level follows the GDP change showing an increase of 1,429 MM AR$ and almost 6 thousand new jobs compared to the 2017 base. In terms of the 2022 BAU for these variables, these increases represent 0.05% for tax revenue and 0.03% for employment. Direct and indirect effects of this lithium production shock across the Argentinean production structure explain almost 79% of GDP and tax revenue total increases and 47% of total employment increase. The remaining percentage of the total impacts are explained by the induced effects by households' consumption due to the increase in their real income. This decomposition of impacts in direct, indirect, and induced effects is possible since we have run the LVC scenarios using an open and a close (in household demand) MRIO models. The open model allows computing direct & indirect effects and computes output and employment multipliers which, in the case of the conservative scenario, are 1.66 and 3.95 respectively (i.e., the initial shock of lithium production under the conservative scenario allows amplifying the value of production of the rest of the economy by a factor of 1.66 while for 1 job created in the lithium sector the economy creates 4 new jobs). The close MRIO model adds a loop that is explained by final consumption of households due to the change in their real income. In this sense, output and employment multipliers become even greater than under the open MRIO model, being those factors 2.14 and 8.41 respectively. In this sense, the impact over employment more than doubles when we consider the increase in households' consumption according to their initial consumption basket of all products and services. The decomposition of effects and multipliers are presented in Table 6.1 in Appendix 6.

Regarding the Moderate and the Optimistic scenarios, impacts in all macroeconomic variables are greater than the Conservative one as shown in Figure 10: while results under the Moderate scenario are around 15-16% greater than the Conservative scenario, results in the Optimistic one are 35-41% greater. The Optimistic scenario also adds a small shock on cell production, whose contribution in the total impact is marginal on macroeconomic variables since, in 2022, cell production is quite incipient and only contributes to 289 new jobs and 329 MM AR$ to the overall GDP economy.

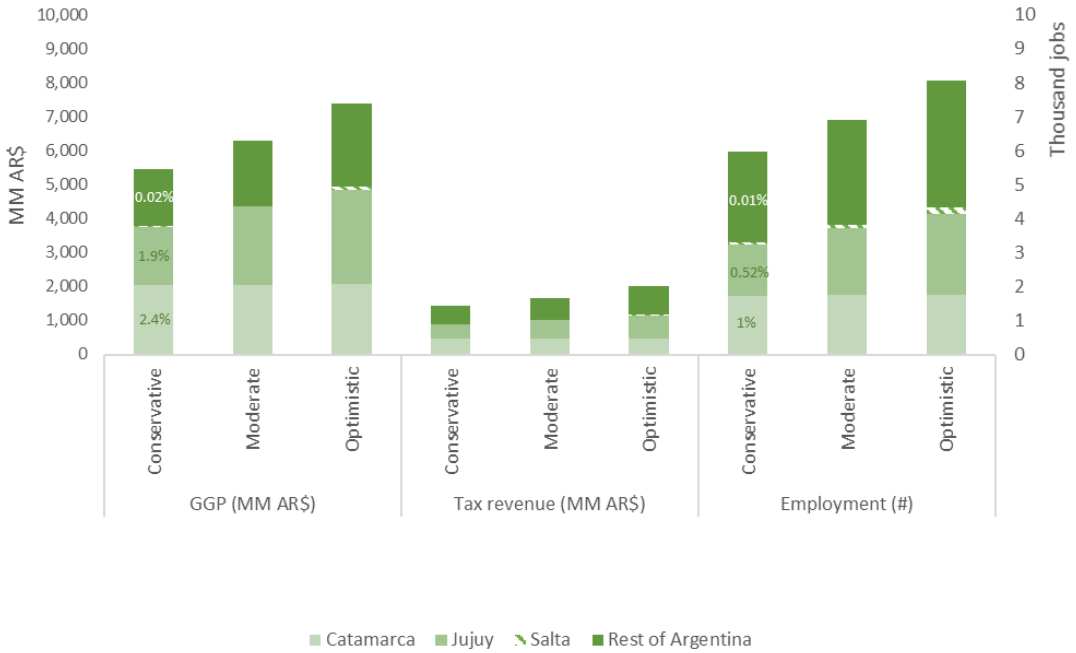
Figure 10. GDP, tax revenue, exports (MM AR$) and employment ('000 jobs) impacts at national level under the LVC scenarios (lithium & cells production) in 2022



Source: Own elaboration
Note: Results represent increases in variables compared to the 2017 MRIO (MM AR$) & SAE ('000 jobs). Labels for the conservative scenario display the percentage increase in terms of the 2022 BAU baseline.

Decomposing national total impacts into a regional one we can see that provinces that will push these impacts are Catamarca and Jujuy, where new lithium projects are expected to increase production capacity. Spillover effects in the rest of Argentina region are as large as those in Catamarca or Jujuy in absolute values and even greater in terms of new jobs creation because labor intensity in the activities in the rest of Argentina are relatively greater than in LVC sectors; however, in terms of the 2022 BAU levels of the rest of Argentina those increases represent 0.03% at most for any of the variables. Concerning Salta, impacts of these LVC scenarios are negligible because none of the new lithium projects is expected to be developed in this province in 2022 and spillover effects are minor in both absolute and in percentage of the 2022 BAU level terms. Figure 11 presents this regional decomposition of GDP, tax revenue and employment impacts of LVC scenarios in 2022 and Table 6.2 (Appendix 6) presents regional results (production, GGP, tax revenue and employment) in absolute terms and in percentage of the 2022 BAU levels of each province/region.

Figure 11. Regional decomposition of GDP, tax revenue (MM AR$) and employment ('000 jobs) impacts under the LVC scenarios (lithium & cell production) in 2022

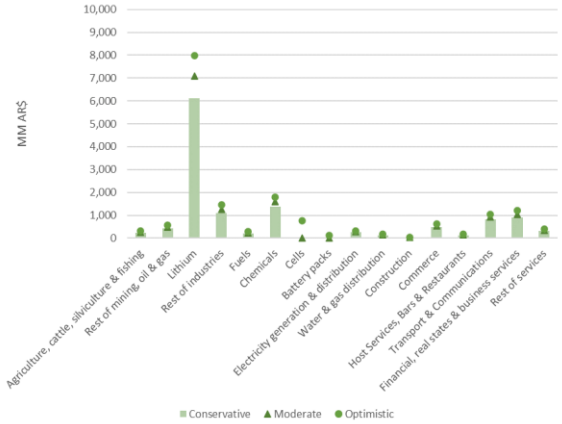


Source: Own elaboration
Note: Results represent increases in variables compared to the 2017 MRIO (MM AR$) & SAE ('000 jobs). Labels for the conservative scenario display the percentage increase in terms of the 2022 BAU levels in each province/region.

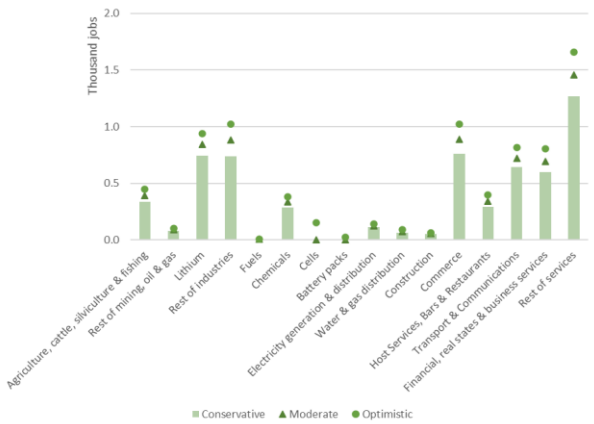
Sectoral decomposition of national results for production (value) in 2022 show that main increase comes from the Lithium sector followed by Chemicals, Rest of industries, Financial, real states & business services and Transport & Communications which are mainly backward linked the LVC upstream. Nevertheless, in terms of new jobs, they are created mainly in service sectors due to the relative labor intensity of them compared to other sectors of the LVC. Comparing across scenarios in 2022 impacts increase with the ambition in each of them, and cell production and employment increase only under the Optimistic scenario. Figure 12 presents these commented results and Table 6.3 complements sectoral impacts at national level.

Figure 12. Sectoral decomposition of production (MM AR$) and employment ('000 jobs) impacts under the LVC scenarios (lithium & cell production) in 2022

A - Production impacts (MM AR$)



B - Employment impacts ('000 jobs)



Source: Own elaboration
Note: Results represent increases in variables compared to the 2017 MRIO (MM AR$) & SAE ('000 jobs).

5.2. Comparison of the three LVC scenarios impacts in 2025 and 2030

Assuming the Conservative 2022 as a current situation (starting point) we analyze and compare the impacts of the three LVC scenarios in a medium (2025) and long (2030) run. The development of the LVC requires, under the three scenarios' assumptions, new investments in the lithium sector to increase its production capacity. Consequently, we compose impacts according to the origin of the shock that are investment or production.

Figure 13 shows national impacts over GDP, Tax revenue, Exports and Employment because of LVC scenarios (conservative, moderate and optimistic) by 2025 and 2030. To analyze 2025 results we must know that before that year the lithium sector needed to build new plants, thus an investment shock in new lithium plants was simulated between 2023-2025 (panel A) to get a production capacity consistent with the lithium production shock in 2025 (panel B). The same procedure was done between 2026-2030 for lithium investments (panel C) to reach the production capacity for the lithium production shock assumed for 2030 (panel D). Remember that under the Optimistic scenario in 2025 production shock also concerns cells and by 2030 the three LVC scenarios assume lithium & batteries (cells and packs) production. The split of investment from production shocks is relevant since results of the former cover more than a one-year period and are associated to duration of the investment projects execution, whereas results due to the production shocks refer to yearly flow gains.

Investments in new lithium plants assumed under the Optimistic scenario allow increasing GDP in around 17 thousand MM AR$ and creating 46.7 thousand new jobs compared to the Conservative 2022 scenario during the period 2023-2025. It means an increase of 0.2% of GDP and 0.21% in employment compared to the 2025 BAU levels of these variables. Lithium investments under the Conservative and the Moderate scenarios also increase GDP but in lower magnitudes - GDP gains under the Conservative scenario are equivalent to 39% of the Optimistic one and under the Moderate scenario the GDP gain is 62% of the Optimistic scenario by 2025. Tax revenue impacts in terms of percentage of the 2025 BAU levels are in line with GDP impacts under the three scenarios (Figure 13 - panel A).

The installation of greater capacity of lithium production allows increasing effective production assumed in each the LVC scenarios by 2025. GDP increases 25.4 thousand MM AR$ under the

Optimistic scenario which represents 0.3% of 2023 GDP in the BAU - GDP gains under the Conservative and Moderate scenarios are lower being 10.2 thousand MM AR$ for the former and 15.8 thousand MM AR$ for the latter. Exports increase in 27 thousand MM AR$ (equivalent to 2% of Exports in the 2025 BAU) under the Optimistic scenario and they correspond to the lithium production increase. Tax revenue increase follows the increase in GDP, being for instance 0.23% greater than its level in the 2025 BAU under the Optimistic scenario. The increases in new jobs due to lithium production shocks are more modest compared with the investment shocks since LVC sectors are relatively less intensive in the use of labor.

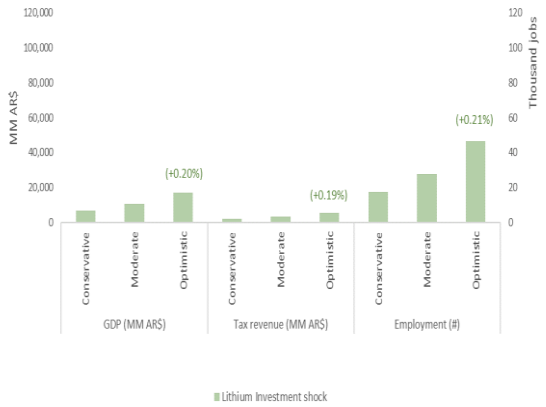
Lithium investment during the 2026-2030 period generates 41.9 thousand MM AR$ (equivalent to 0.45% of GDP level in the 2030 BAU as reference) and 117.4 thousand new jobs under the Optimistic scenario since the activities linked to the new lithium plants investments are labor-intensive. GDP increase under the Conservative and Moderate scenarios are 56% and 66% respectively of GDP increase in the Optimistic one. Tax revenue impacts are in line with GDP increase under all scenarios (Figure 13 - panel C). Exports are not affected by these shocks of lithium investment, so they are not shown in panels A & C.

By 2030 the scenarios concerning the development of the LVC are more complex and add some linkages from lithium extraction to battery production. Concerning the production shocks, by 2030 the development of the LVC (lithium extraction + cells and battery packs production) contribute to an increase of 62.9 thousand MM AR$ in the GDP under the Optimistic scenario compared to the 2022 Conservative scenario (equivalent to 0.73% of the GDP level in the 2030 BAU, being the GDP gains under the Conservative and Moderate scenarios of 0.41% and 0.49% respectively with the same base of comparison). Tax revenue at the country level increases 16.9 thousand MM AR$ under the Optimistic scenario (0.59% of Tax revenue in the 2030 BAU) and Exports also increase 5.61% under the same scenario in 2030. The LVC allows increasing employment in 82.5 thousand jobs (+0.33%) by 2030 under the Optimistic scenario, from which the production of cells and battery packs only contribute 4.5 thousand jobs from that total (Figure 13 - panel D).

In terms of production and employment multipliers of these LVC scenarios, the multipliers of the lithium investment shocks are comparatively modest to the LVC production shocks' multipliers. For investment shocks both production and employment multipliers are close to 2, being systematically production multipliers greater than employment one. For LVC production shocks, the production multipliers are between 1.6 (open model) and 2.1 (close model) while employment multipliers are between 4 (open model) and 9 (close model) depending on the ambition of LVC scenarios in 2025 and in 2030. In general terms, multipliers are slightly smaller in scenarios in 2030 than in 2025 due to the introduction of cell and battery pack production (relatively more labor intensive than lithium extraction activity). Multipliers are presented in Table 6.4 in the Appendix 6.

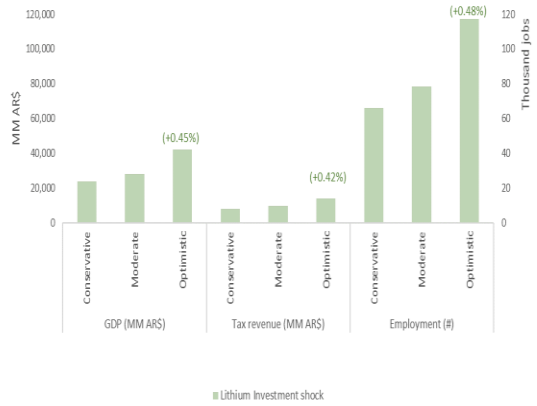
Figure 13. GDP, tax revenue, exports and employment results at national level under the LVC scenarios: lithium investment impacts and LVC production impacts for 2025 and 2030

A- Lithium investment impacts (2023-2025)

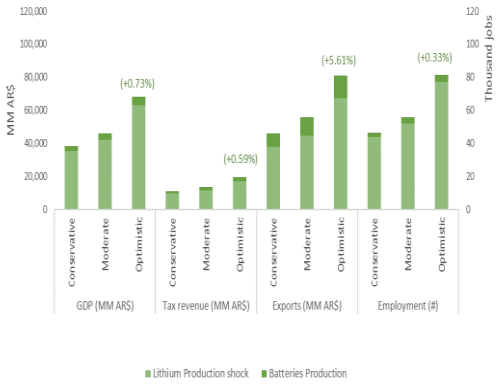


B- Lithium production impact (2025)

C- Lithium investment impacts (2026-2030)



D- Lithium, cells & packs production impacts (2030)



Source: Own elaboration

Note: Results in GDP, Tax revenue and Exports are presented as additional gains in million (MM) Argentinean pesos (AR$) to the Conservative scenario in 2022 and for employment gains are presented in terms of thousand new jobs compared to the Conservative scenario in 2022. Moreover, labels highlight percentage changes of the Optimistic scenario compared to the baseline situation during the same year (BAU scenario assumes an average increase of 1.3% GDP per year from 2022 to 2030).

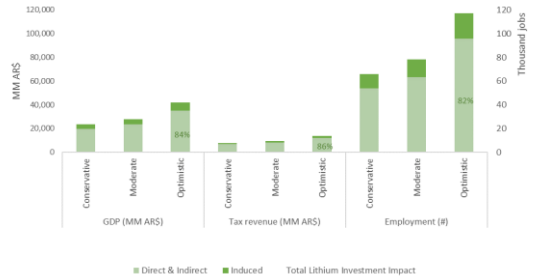
In short, we can say that at national level, the development of the LVC under any of the three scenarios displays positive net impacts on socioeconomic variables (value of production, GDP, employment, tax revenue and exports). While the investment of new lithium plants generates more direct employment due to the construction activity, the lithium production phase pushes the rest of sectors in the economy mainly through backward productive linkages. Induced effects by the increase of real income in households are also relevant which feed impacts especially on non-LVC sectors. Production of cells and battery packs contributes marginally in 2030 to the total socioeconomic impacts due to the assumed relatively small scale of those sectors.

As it can be mentioned before, lithium investment and LVC production shocks in the LVC scenarios can be decomposed in direct, indirect, and induced effects. Figure 14 presents the results for the horizon 2030. Panel A displays that at least 80% of the total GDP, tax revenue and employment impacts under the Optimistic scenario are explained by direct & indirect effects due the new projects of investments in lithium plants between 2026-2030. Panel B shows that under the lithium, cells & battery packs production shocks 80% of GDP and tax revenue total impacts are due to direct & indirect

effects, while for employment more than a half of total impact is an induced effect (pushed by household demand due to a purchasing power improvement) by 2030. This employment result means that new employment is mostly generated outside the LVC, in sectors which are relatively more labor-intensive (e.g., services) and explained by the spillover effects of the LVC production on the rest of the economy.

Figure 14. Decomposition in direct, indirect & induced effects of GDP, tax revenue and employment results at national level under LVC scenarios: lithium investment impacts (panel A) and LVC production impacts (panel B) by 2030

A- Lithium investment impacts (2026-2030)



B- Lithium and batteries (cells & packs) production (2030)

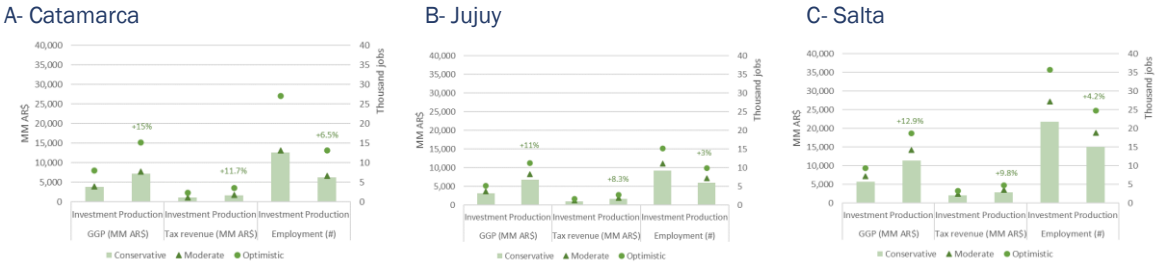
Source: Own elaboration

Note: Results in GDP and Tax revenue are presented as additional gains in million (MM) Argentinean pesos (AR$) to the Conservative scenario in 2022 and for employment gains are presented in terms of thousand new jobs also compared to the Conservative scenario in 2022. Labels for the Optimistic scenario's results show the percentages of total increases explained by direct & indirect effects.

Same results can also be decomposed across the three lithium-rich provinces and the rest of Argentina where the LVC downstream sectors could be developed. Figure 15 presents GGP, tax revenue and employment impacts under the three LVC scenarios by 2030 for the three lithium-rich provinces (Catamarca, Jujuy, and Salta). Such as done before we present lithium investment and LVC production shocks separately since timing and duration of impacts are different. Bars show the impacts under the Conservative scenario in 2030 compared to 2022, and dots display additional gains of the Moderate and Optimistic scenarios. Greater LVC production under the Optimistic scenario leads to the GGP increase of 15% in Catamarca, 11% in Jujuy and 12.9% in Salta compared to GGP in the 2030 BAU for each province. Tax revenue at the province level also would increase 11.7%, 8.3% and 9.8% respectively, and employment would reach 13 thousand new jobs in Catamarca, 9.8 thousand new jobs in Jujuy and 24.7 thousand new jobs in the province of Salta due to the same LVC production shock. These results are not negligible for provinces and should be considered. Lithium investment impacts for the period 2026-2030 are lower compared to LVC production impacts on both GGP and tax revenue in the three provinces; however, during the period of the investment project execution the employment considerably increases since those sectors are relatively more labor-intensive. Nonetheless, remember that both shocks are not fully comparable since investment impacts refer to a period of the investment execution (greater than one year) and production impacts provide yearly flows for each variable.

Moreover, remember that the three LVC scenarios by 2030 assumes that LVC downstream sectors would develop their activities in the rest of Argentina since this region conglomerates the main industrial poles of the country. Nevertheless, this assumption of the battery industry could be also adapted if it is pertinent.

Figure 15. Regional (3 lithium-rich provinces) GGP, tax revenue and employment impacts of LVC scenarios decomposed by lithium investment 2026-2030 shock & LVC production shocks by 2030.

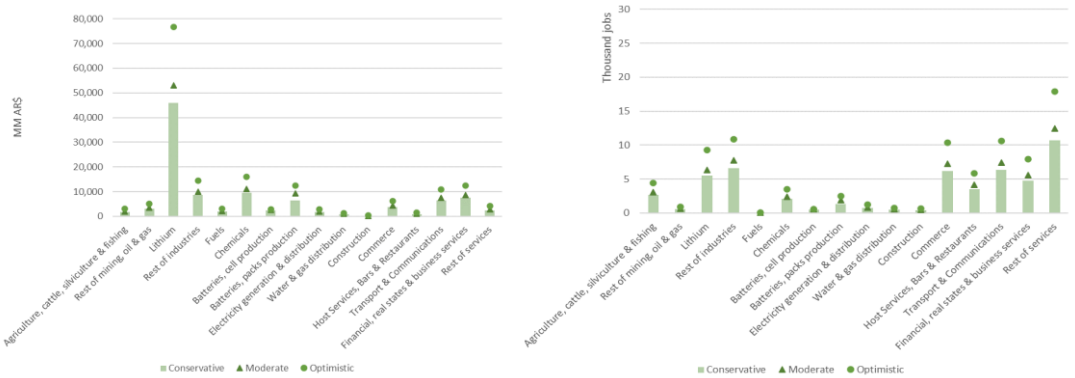


Source: Own elaboration
Note: GGP and tax revenue gains are measured in MM AR$ and employment increase in new thousand jobs additional to 2022 conventional scenario. Labels are displayed for the LVC production shocks under the Optimistic scenario showing percentage changes compared to the 2030 BAU levels.

In short, we can say that the location of investment in new lithium plants that expand production capacity and thus lithium production determine the direct regional effects which mainly drive the increase in the GGP and employment in the three lithium-rich provinces. Moreover, a greater scale for the lithium sector and even the development of the LVC linkages (LVC downstream sectors) would lead to spillover effects in the rest of Argentina according to all socioeconomic indicators' results. Table 6.5 in Appendix 6 also presents results for the rest of Argentina.

Finally, to analyze the sectoral impacts of the development of the LVC in Argentina, we present production and employment results in Figure 16, panels A and B respectively. Both panels in this figure present the impacts of the three LVC production scenarios in 2030. Panel A presents the production impact (in MM AR$) at the sector level (here we have aggregated in 16 main sectors) where the lithium production is evidently the driver of all spillover effects over the rest of sectors in the economy. Lithium production under the Optimistic scenario would increase 76,593 MM AR$ that is 70% greater than lithium production under the Conservative scenario in 2030. This shock mainly tracks sectors such as Chemicals, Rest of industries, Rest of services and Batteries packs. Panel B presents employment impacts of the same shock (LVC production) under the three LVC scenarios by 2030. In this case main new jobs would come from service sectors, such as Rest of services, Transport & Communications, Commerce, and Financial, Real States & Business Services, which are relatively more labor-intensive than LVC sectors.

Figure 16. Sectoral production and employment impacts at national level under the LVC scenarios (LVC production shock) by 2030



Source: Own elaboration
Note: Results of production (MM AR$) and employment ('000 jobs) increase are related to the 2022 Conservative situation.

6. Final remarks

In the next future, the acceleration of the expansion of renewable energies and the electromobility, mainly motivated for environmental reasons, appears as one of drivers for the development of the LVC in developing economies. Argentina presents great advantages in terms of the lithium endowment. However, investment and production projects in the lithium-rich provinces are at an incipient stage (Catamarca, Salta, and Jujuy). The main purpose of this report was to analyze the potential socioeconomic impacts of the development of the LVC on the Argentine economy. We provided a quantitative estimate of the potential economic contribution of the LVC-related activities considering the national, regional, and sectoral levels.

For that purpose, we have developed a MRIO matrix with its associated SAE to measure the employment impact. With these datasets we have calibrated a MRIO model that isolates the three lithium-rich provinces and the rest of the country with a sectoral detail of 35 sectors in each region from which 6 of them make up the LVC. Three scenarios (conservative, moderate and optimistic) have been designed with increasing levels of ambition regarding activities related to the lithium-ion battery value chain: lithium compounds, lithium-ion batteries, electromobility and renewable energies. Moreover, targets in each of them are set for three temporal horizons: 2022, 2025 and 2030.

Simulation results highlight that under any of three scenarios and temporal horizons, all socioeconomic variables display net positive impacts at the national level. Investment phases of the lithium development generates value-added and employment during the construction period of new plants, but multipliers of production and employment are less important compared to those from the lithium production phase. In this sense, the LVC production leads to greater value of production and employment yearly, allowing for not negligible spillover effects (indirect and induced) as the scale of lithium increases based on the ambition of scenarios and by 2030. The development of the LVC downstream sectors mainly assumed by 2030 and under the Optimistic scenario shows a marginal contribution at the national level but looking at regional level they could contribute with more than 10% of GGP and more than 5% increase of new jobs in each lithium-rich province. It is important to note that even when main investment and production of the LVC are concentrated in the three lithium-rich provinces, the increase in the value added and employment also extents to the rest of the country due to regional/sectoral productive interactions (indirect effects) and due to the increase in households' real income that increase demand across all final goods and services supplied in the economy (induced effect). Sectoral impacts are driven by direct impacts of the LVC sectors but also through spillover effects observed particularly on those sectors that provide inputs and services to the LVC (chemicals, fuels, transport, financial and business services) but also on others from which lithium is an input, such as for batteries production (cells) located in the rest of the country under an Optimistic perspective scenario by 2030.

The deeper ambition in the development of the LVC in Argentina (scale of production and LVC linkages), the greater the spillover effects on socioeconomic variables across sectors (not necessarily LVC sectors) and regions of the country (not exclusively the three lithium-rich provinces).

7. References

Bacharach, M. 1970. *Biproportional matrices & input-output change*. Cambridge University Press, Cambridge.

Bernhart, W. 2019. Challenges and Opportunities in Lithium-ion Battery Supply. Future Lithium-ion Batteries. A. Eftekhari. London, The Royal Society of Chemistry: 316-334.

BIS Research. 2021. Electric Vehicle (EV) Battery Housing Market - A Global and Regional Analysis.

Bonfiglio, A., & Chelli, F. 2008. Assessing the Behaviour of Non-Survey Methods for Constructing Regional Input–Output Tables through a Monte Carlo Simulation. Economic Systems Research, 20(3), 243–58.

Cheng, X.-B., C.-Z. Zhao, Y.-X. Yao, H. Liu and Q. Zhang. 2019. "Recent Advances in Energy Chemistry between Solid-State Electrolyte and Safe Lithium-Metal Anodes." Chem 5(1): 74-96.

Chisari, O. O., Mercatante, Juan I., Ramos, M. Priscila y Carlos A. Romero. 2020. *Estimación y calibración de una Matriz de Contabilidad Social para la economía argentina de 2017*. Serie Documentos de Trabajo del IIEP, 54, 1-39. http://iiep-baires.econ.uba. ar/documentos_de_trabajo.

Duan, J., L. Huang, T. Wang, Y. Huang, H. Fu, W. Wu, W. Luo and Y. Huang. 2020. "Shaping the Contact between Li Metal Anode and Solid-State Electrolytes." Advanced Functional Materials 30(15): 1908701.

Eftekhari, A. 2019. Future Lithium-ion Batteries. Royal Society of Chemistry; 1st edition.

European Parliament. 2018. Battery-powered electric vehicles : market development and lifecycle emissions : research for TRAN Committee. European Parliament - Directorate-General for Internal Policies of the Union.

Fact.MR. 2019. Lithium-ion Battery Cathode Market Forecast, Trend Analysis & Competition Tracking - Global Market Insights 2019 to 2029: 170.

Farina, P., Drucaroff, Sergio y Rivas Diego. 2020. “Oportunidades y desafíos para el desarrollo productivo en el marco de la transición energética argentina”, Documento de trabajo Nº 199, CIPPEC.

Farina, P., Drucaroff, Sergio y Rivas Diego. 2020. “De la crisis a la oportunidad del sector energético: escenarios y condiciones para ampliar la oferta a 2050”, Documento de trabajo Nº 200, CIPPEC.

Flegg, A., Mastronardi, L., & Romero, C. 2016. Evaluating the FLQ and AFLQ Formulae for Estimating Regional Input Coefficients: Empirical Evidence for the Province of Córdoba, Argentina. *Economic Systems Research, 28*(1), 21-37. https://doi.org/10.1080/09535314.2015.1103703.

Flegg, A. T., Webber, C. D. & Elliott, M. V. 1995. On the Appropriate Use of Location Quotients in Generating Regional Input–Output Tables. Regional Studies, 29, 547-561.

Flegg, A., Thomo, T. 2016. Refining the Application of the FLQ Formula for Estimating Regional Input Coefficients: An Empirical Study for South Korean Regions. University of West of England, Economic Working Paper 1605.

Flexer, V., C. F. Baspineiro and C. I. Galli. 2018. "Lithium recovery from brines: A vital raw material for green energies with a potential environmental impact in its mining and processing." Science of The Total Environment 639: 1188-1204.

Gabinete Nacional de Cambio Climático. Ministerio de Energía. Ministerio de Ambiente y Desarrollo Sustentable. 2017. Plan de Acción Nacional de Energía y Cambio Climático. Versión I - 2017. Presidencia de la Nación Argentina. plan_de_accion_nacional_de_energia_y_cc_2.pdf (argentina.gob.ar)

Gonzalez, Sebastian Nicolas; Romero, Carlos Adrián; Ramos, Maria Priscila; Negri, Pablo Augusto; Marino, Matias Daniel. 2021. The App-RegMIP: an open access software for regional input-output tables estimation. Inderscience Enterprises, *International Journal of Computational Economics and Econometrics*; 1; 1; 6-2021; 1-19. http://doi.org/10.1504/IJCEE.2021.10038403

Jones, B., F. Acuña & V. Rodríguez. 2021. Cambios en la demanda de minerales. Análisis de los mercados del cobre y el litio, y sus implicaciones para los países de la región andina. Santiago de Chile, Comisión Económica para América Latina y el Caribe.

Jorratt, Michel. 2022. Renta económica, régimen tributario y transparencia fiscal en la minería del litio en Argentina, el Estado Plurinacional de Bolivia y Chile. Santiago: CEPAL . En prensa.

König, A., Nicoletti, L., Schröder, D., Wolff, S., Waclaw, A., & Lienkamp, M. 2021. An overview of parameter and cost for battery electric vehicles. *World Electric Vehicle Journal*, *12*(1), 21.

Kowalewski, J. 2013. Regionalization of National Input–Output Tables: Empirical Evidence on the Use of the FLQ Formula. Regional Studies ,49(March),37–41.

Leurent, F., & Windisch, E. 2015. Benefits and costs of electric vehicles for the public finances: An integrated valuation model based on input–output analysis, with application to France. *Research in Transportation Economics*, *50*, 51-62.

López, A., Obaya, M., Pascuini, P., & Ramos, A. 2019. *Litio en la Argentina: Oportunidades y desafíos para el desarrollo de la cadena de valor* (Vol. 698). Inter-American Development Bank.

Mayyas, A., D. Steward and M. Mann. 2019. "The case for recycling: Overview and challenges in the material supply chain for automotive li-ion batteries." Sustainable Materials and Technologies.

Miller, R., & Blair, P. 2009. *Input-Output Analysis. Foundations and Extensions.* Cambridge: Cambridge University Press.

Ministry of Treasury. 2018. Informe de cadenas de Valor: Litio.

Obaya, Martín & López, Andrés & Pascuini, Paulo. 2021. *"Curb your enthusiasm. Challenges to the development of lithium-based linkages in Argentina," Resources Policy*, Elsevier, vol. 70(C).

Obaya, M. and M. Céspedes. 2021. Análisis de las redes globales de producción de baterías de ion de litio. Implicaciones para los países del triángulo del litio. Santiago, Documentos de Proyectos (LC/TS.2021/58) CEPAL.

Romero, C., Mastronardi, L. & Vila Martínez, J. P. 2018. Desarrollo de Vaca Muerta: Impacto económico agregado y sectorial. Documento de Trabajo No. 6. Ministerio de Producción & Ministerio de Energía y Minería de la Nación argentina. Junio. Disponible en: https://www.researchgate.net/publication/331585212_Desarrollo_de_Vaca_Muerta_Impacto_economico_agregado_y_sectorial

Romero, C., Mastronardi, L., Tarelli, J. & Haslop, F. 2020. The Regional Impact of Tourism when Data is Scarce. An Application to the Province of Salta, Tourism Planning & Development, 17:4, 441-457, DOI: 10.1080/21568316.2019.1673808

Schteingart, D. and Allerand, M. 2021. The impact of Argentine mining on local suppliers. CCE Working Papers N° 19, Consejo para el Cambio Estructural - Ministerio de Desarrollo Productivo de la Nación.

Secretaría de Minería. 2021. "Informe Litio 2021", Buenos Aires, Secretaría de Minería-Ministerio de Desarrollo Productivo de la Nación. Disponible en https://www.argentina.gob.ar/sites/default/files/informe_litio_2021_final.pdf

Sharova, V., P. Wolff, B. Konersmann, F. Ferstl, R. Stanek and M. Hackmann. 2020. Evaluation of Lithium-Ion Battery Cell Value Chain, Working Paper Forschungsförderung.

Schteingart, D. and M. Allerand. 2021. El impacto de la minería argentina en los proveedores locales. Buenos Aires, Documentos de Trabajo del CCE N° 19, Consejo para el Cambio Estructural - Ministerio de Desarrollo Productivo de la Nación.

Szenkman, Paula & Barafani, Magdalena & Cardozo, Javier & Vila, Juan & Sánchez, Jorge & Romero, Carlos. 2019. "Estimación de *impacto y la demanda de gas para trazar una hoja de ruta a 2030*".

Tohmo, T. 2004. New Developments in the Use of Location Quotients to Estimate Regional Input–output Coefficients and Multipliers. Regional Studies ,38, 43–54.

USGS. 2021. Mineral Commodity Summaries 2020, Reston Virginia. U.S. Geological Survey.

Weimer, L., Braun, T., & Hemdt, A. v. 2019. Design of a systematic value chain for lithium-ion batteries from the raw material perspective. Resources Policy, 64.

World Bank. 2021. Jobs and Distributive Effects of Infrastructure Investment: The Case of Argentina. World Bank.

Appendix 1. Lithium value chain information

Table 1.1. Advanced lithium projects in Argentina

Project	Operador	Provincia	Stage	Production capacity ('000 t/LCE per year)	Investment (MM US$)
Mina Fenix	Livent Corporation	Catamarca	Production	20	300
Salar de Olaroz	Sales de Jujuy (Allkems, Toyota Tsusho, JEMSE)	Jujuy	Production	25	285
Cauchari-Olaroz	Minera Exar (Lithium Americas, Ganfeng, JEMSE)	Jujuy	Construction	40	565
Pastos Grandes	Lithium Americas	Salta	Feasibility	24	448
Sal de Oro	Posco	Salta	Advanced exploration	25	500
Sal de Vida	Allkems	Catamarca	Feasibility	25	474
Rincon Lithium Project	Argosy Minerals	Salta	Preliminary economic assessment	10	141
Salar del Rincón	Rincon Lithium	Salta	Feasibility	25	599
Tres Quebradas	Neo Lithium	Catamarca	Pre-feasibility	20	319
Centenario Ratones	Eramet	Salta	Feasibility	24	595
Mariana	Litio Minera Argentina, International Lithium Corp.	Salta	Preliminary economic assessment	10	243
Sal de los Ángeles	Tibet Summit	Salta	Preliminary economic assessment	25	338
Kachi	Lake Resources	Catamarca	Pre-feasibility	25.5	544
Cauchari	Allkems	Jujuy	Pre-feasibility	25	446
PPG	Plus Petrol	Salta	Preliminary economic assessment	25	338
Salar del Hombre Muerto Norte	NRG Metals	Salta	Preliminary economic assessment	5	93
Salar del Hombre Muerto Oeste	Galan Lithium Ltd.	Catamarca	Preliminary economic assessment	20	439
Candelas	Galan Lithium Ltd.	Catamarca	Advanced exploration	n.d.	n.d.
Pular	Pepinninni Lithium Ltd.	Salta	Advanced exploration	n.d.	n.d.
Rincón	Pepinninni Lithium Ltd.	Salta	Advanced exploration	n.d.	n.d.
Río Grande	Plus Petrol	Salta	Advanced exploration	n.d.	n.d.
Gallego	Everlight Resources	Salta	Advanced exploration	n.d.	n.d.
Salinas Grandes	Plus Petrol	Jujuy	Advanced exploration	n.d.	n.d.

Source: Secretaría de Minería (2021), "Informe Litio 2021", Buenos Aires, Secretaría de Minería-Ministerio de Desarrollo Productivo.

Table 1.2. Capital expenses for the construction of new lithium project in Argentina - Project Cauchari Olaroz - Minera Exar - Production capacity 40,000 metric ton LCE

	MM USD	%
Lithium carbonate plant	174.9	31%
Evaporation ponds	145.3	26%
Reagents	12.4	2%
On-site Infraestructure	72.5	13%
Off-site services	13.3	2%
Brine wells and pipes	50	9%
Contingencies	9.4	2%
Indirect costs	86.8	15%
Total	**565**	**100%**

Source: https://www.lithiumamericas.com/_resources/pdf/investors/AIF/2020.pdf?v=0.477

Table 1.3. Capital expenses for the construction of new lithium project in Argentina - Proyecto 3 quebradas - 20,000 metric tons LCE

Summary	Equipment		Construction						Total Cost USD
	Imported USD	National USD	Material USD	Labor (All In)		Subcontract		Total Cost USD	
				Total HH	Total Cost USD	Total HH	Total Cost USD		
Direct Cost									
Salar	**9.356.340**	**11.633.221**	**35.601.248**	**1.149.685**	**38.280.179**	**0**	**33.181.376**	**107.062.803**	**128.052.364**
Wells	0	275.625	119.705	5.841	189.288	0	716.735	1.025.728	1.301.353
Preconcentration pond	0	385.35	21.524.872	686.526	22.453.724	0	0	43.978.596	44.363.946
Pond and thickeners of calcium chloride	7.587.300	1.274.442	5.052.645	186.14	6.694.580	0	0	11.747.225	20.608.967
Salt storage facility	1.769.040	1.639.579	8.378.524	240.067	8.129.299	0	0	16.507.822	19.916.441
Building	0	0	0	0	0	0	0	0	0
Salar access road	0	0	0	0	0	0	17.779.256	17.779.256	17.779.256
Electrical generation	0	0	0	0	0	0	13.555.385	13.555.385	13.555.385
Harvesting equipment	0	966	0	0	0	0	0	0	966
Utilities	0	7.092.225	525.503	31.111	813.288	0	1.130.000	2.468.791	9.561.016
Fiambalá	**5.801.250**	**6.264.154**	**7.621.007**	**678.925**	**26.936.407**	**0**	**9.218.200**	**43.775.614**	**55.841.018**
Solvent extraction	2.173.500	339.424	1.316.231	78.463	2.630.025	0	0	3.946.255	6.459.179
Sulfate addiction	3.627.750	2.282.805	2.688.333	362.217	18.907.271	0	0	21.595.605	27.506.160
Reagents	0	0	1.350.678	72.171	1.670.641	0	0	3.021.318	3.021.318
Truck workshop	0	735	673.092	35.374	827.79	0	100	1.600.882	2.335.882
Electrical supply	0	0	0	0	0	0	7.550.000	7.550.000	7.550.000
Building	0	2.906.925	1.592.673	130.7	2.900.681	0	1.568.200	6.061.554	8.968.479
Recreo	**12.294.555**	**3.411.829**	**21.953.724**	**923.05**	**24.603.182**	**0**	**1.448.800**	**48.005.707**	**63.712.091**
General	0	0	1.172.420	81.618	1.791.904	0	918.8	3.883.124	3.883.124
Purification	4.860.555	388.295	2.066.325	42.165	2.360.005	0	0	4.426.330	9.673.180
Carbonation	572,25	280.309	6.552.811	225.839	6.126.220	0	0	12.679.032	13.531.591
Dying and Packaging	4.131.750	508.725	5.346.977	222.607	5.752.774	0	0	11.099.750	15.740.225
Reagents	0	0	5.892.006	300.351	7.095.330	0	0	12.987.337	12.987.337
Vendors packages	0	0	0	0	0	0	0	0	0
Utilities	2.730.000	2.236.500	923.185	50.471	1.476.949	0	530	2.930.135	7.896.635
Catamarca	0	94.5	0	0	0	0	19.875	19.875	114.375
General	0	94.5	0	0	0	0	19.875	19.875	114.375
Total direct cost	**27.452.145**	**21.403.704**	**65.175.979**	**2.751.660**	**89.819.769**	**0**	**43.868.251**	**198.863.999**	**247.719.848**
Project indirect cost									
Freight and insurance costs	2.745.215	642.111	1.955.279	0	0	0	0	1.955.279	5.342.605
Duties	2.196.172	0	0	0	0	0	0	0	2.196.172
Spare parts	1.372.607	1.070.185	0	0	0	0	0	0	2.442.792
Vendor representatives	0	0	0	0	0	0	15.7	15.7	15.7
Feasibility engineering	0	0	0	0	0	0	1.440.000	1.440.000	1.440.000
EPC						0			
Detailed engineering	0	0	0	0	0	0	2.520.000	2.520.000	2.520.000
QA/QC	0	0	0	0	0	0	540.059	540.059	540.059
Procurement	0	0	0	0	0	0	594	594	594
First Fill	0	0	9.005.289	0	0	0	0	9.005.289	9.005.289
Owner cost	0	0	0	0	0	0	0	0	0
Total indirect cost	**6.313.993**	**1.712.296**	**10.960.568**	**0**	**0**	**0**	**5.109.759**	**16.070.327**	**24.096.617**
Total	**33.766.138**	**23.116.000**	**76.136.547**	**2.751.660**	**89.819.769**	**0**	**48.978.010**	**214.934.326**	**271.816.464**

Source: P. 250 https://www.neolithium.ca/pdf/Amended-Prefeasibility-Study-(PFS)-Tres-Quebradas-Project-May-7-2019.pdf

Table 1.4. Capital expenses for the construction of new lithium project in Argentina - Lithium Americas (Sal de Vida) - Original project: Production capacity 32,000 metric tons LCE

Direct costs	MM USD	%
Wellfield & Brine Distribution	7	5%
Evaporation ponds and waste	40	26%
Lithium carbonate plant	38	25%
Utilities	13	8%
Infrastructure	7	5%
General	8	5%
Owner's costs	11	7%
Engineering	15	10%
Contingency	15	10%
Total	**154**	**101%**

Source: Feasibility Study 2021. https://wcsecure.weblink.com.au/pdf/GXY/02363235.pdf

Table 1.5. Operating costs - Lithium Americas

	Total (US$ 000s/Year)	Allocation of Total OPEX (%)
Direct costs		
Reagents	72,535	51%
Maintanance	16,143	11%
Electric Power	6,408	4%
Pond Harvesting & Tailing Management	13,334	9%
Water Treatment System	356	0%
Natural Gas	5,818	4%
Manpower	12,809	9%
Catering, Security & Third-Party Services	4,534	3%
Consumables	959	1%
Diesel	101	0%
Bus-in / Bus-Out Transportation	213	0%
Product Transportation	5,072	4%
Direct Costs Subtotal	**138,282**	**97%**
Indirect Costs		
G&A	4,884	3%
Indirect Costs Subtotal	**4,884**	**3%**
Total Operating Costs	**143,166**	**100%**

Source: https://www.lithiumamericas.com/_resources/pdf/investors/AIF/2020.pdf?v=0.477

Table 1.6. Operating Costs - Tres Quebradas (Millenial Lithium) - 20,000 metric tons LCE - USD

	Total (US$ 000s/Year)	Allocation of Total OPEX (%)
Manpower	420	14%
Reagents	1469	50%
Power	318	11%
Salt Harvesting Equipment	98	3%
Maintenance	80	3%
Brine Transportation	266	9%
Lithium Carbonate Transportation	89	3%
General Expenses	174	6%
Product transportation		
Total	**2,914**	**100%**

Source: based on Jorratt (2022).

Table 1.7. Operating costs - Galaxy Resources (Sal de Vida) - Original project: production capacity 32,000 metric ton LCE

	Total (US$ 000s/Year)	Allocation of Total OPEX (%)
Reagents	1,746	51%
Energy	290	9%
Maintenance	252	7%
Salt removal and transportation	174	5%
Manpower	443	13%
Product transportation	194	6%
Other direct costs	310	9%
Total	**3,410**	**100%**

Source: https://www.listcorp.com/asx/gxy/galaxy-resources/news/sal-de-vida-updated-feasibility-study-1885522.html

Table 1.8. List of experts consulted and interviewed

Name	Position	Institution
Felix Requejo	Scientific Director	UniLIB Project (Y-TEC-University of La Plata)
Sergio Drucaroff	Associate Researcher	Centro de Implementación de Políticas Públicas para la Equidad y el Crecimiento (CIPPEC)
Fernando Porta	Researcher	Centro Interdisciplinario de Estudios de Ciencia, Tecnología e Innovación (CIECTI)
Víctor Delbuono	Researcher	Fundación para el Desarrollo Argentino (FundAR)
Juan Pablo Zagorodny	Independent Consultant	
Carlos Aggio	Researcher	Centro Interdisciplinario de Estudios de Ciencia, Tecnología e Innovación (CIECTI)
Florencia Balastro	Expert on Renewable energies policies	World Bank

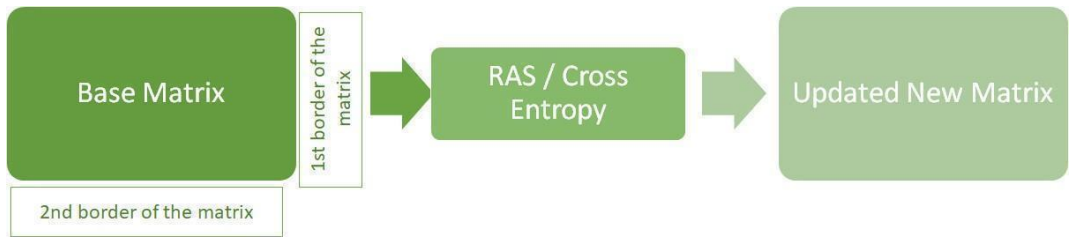
Appendix 2. MRIO: methodological details

Since sector-region data is incomplete and the available one comes from different sources leading to calculation errors in the distribution of the totals, it is necessary to apply two types of **data treatment methods** to, first, estimate the missing sector-region relationships in the matrix and then, correct data inconsistencies when supply-demand differences appear.

The construction of a regional input-output model faces some difficulties. In general, there is scarcity of data because of the limitations of regional surveys or absence of them. Hence, the use of national IO coefficients for adapting regional values is used through production and employment data from national and regional levels. The simplest type of location quotient (LQ) is defined as the ratio between the regional and national proportions of output or employment attributable to a particular industrial sector. The main difficulty is that LQ overstates multipliers which arise from the fact that conventional location quotients do not consider the interregional trade properly. For this reason, the FLQ methodology will be applied to estimate the intra-provincial intermediate purchases and sales. This methodology mainly tries to record the regional purchases from other regions according to the assumption that there is an inverse relationship between the size of the region and the import trend from the other region in the country (Flegg et al. 1995). The use of FLQ for provinces of Córdoba (Romero et. al 2016) and Buenos Aires (González et al. 2021) shows an outperformance over other location quotients such as simple location quotient (SLQ) and cross-industry location quotient (CILQ). There are similar patterns for Scotland (Bonfiglio and Chelli 2008), Germany (Kowalewski 2013), Finland (Tohmo 2004) and South Korea (Flegg and Tohmo 2016) in terms of the useful FLQ method[2].

Once this step is completed, the rest of quadrants of the MRIO matrix scheme are adjusted using the RAS (or cross entropy) methodology for consistency. The RAS method is an algorithm that, starting from a base matrix A and vectors containing the required total sums of the rows and columns, searches for a matrix A* (Updated New matrix in Figure 5) which represents the intermediate sales of industries that respects the row and column totals. The evolution of the iterative process orders the coefficients and disorder each of them in each iteration, until the algorithm finds the new matrix without errors (Miller and Blair 2009). The RAS method has some attractive properties which undoubtedly contribute to its popularity and validity; but it also has other disadvantages since it requires data availability that detract from the flexibility of the method[3].

Figure 2.1. Scheme of estimation of inter-regionals quadrants



Source: Own elaboration

K.2.1. FLQ Method

As it is demonstrated in Romero et al. (2020), the regionalized coefficient through the FLQ method is defined as:

$$FLQij = \frac{\frac{GGPi}{GDPi}}{\frac{GGPj}{GDPj}} * \boldsymbol{\lambda}$$

where GGP represents the production of the provinces and GDP represents the production at national levels. The subindex i and j represent the industries. On one hand, the first term of multiplication allows us to observe the relationship between i and j industries, assuming that the industry i provides inputs to sector j. If the supplying sector is relatively small regionally to the purchasing sector, the regions would have to import from outside the region. This is the value added of the *Cross-industry location quotient*. On the other hand, at the other side of the multiplication, the $\boldsymbol{\lambda}$ is a scalar that it is defined as:

$$\boldsymbol{\lambda} = [log_2(1 + \sum_i Q_I^r / \sum_i Q_I^n)]^{\delta}$$

where Q^{r}_{i} is regional output in sector i and Q^{n}_{i} is the national output in sector i. With the symbol of summation Q^{r}_{i} and Q^{n}_{i} show the regional and national totals. Romero et al. (2019) found for the Cordoba´s province that FLQ performs better with around 0.1. Henceforth these equations, the industry-disaggregated GDP levels of the region and national in the same year are necessary for the application, as well as the same level of desegregation sector for regional and national levels. The application of location quotients has a key assumption that regional technologies are equal to the national average.

K.2.2. RAS Method

For understanding the RAS method, we can assume that we have an input–output direct input coefficient table for an N-sector economy (Matrix A) and that we would like to update those coefficients based on new changes in the input-output matrix (Matrix A*). As the economy counts with N sector, the coefficient matrix has nxn coefficients for the N sectors in the economy. As it mentioned in Miller and Blair (2009), the RAS method generates the estimation of these coefficients from 3n pieces of information which included *total gross output*, *total interindustry sales,* and *total industry purchases*. Henceforth, it consists of an iterative procedure that searches for vectors r_i and s_j such that: a_{ij}*= r_i a_{ij} s_j. The r_i refers to a diagonal matrix of elements modifying rows, the a_{ij} is related to the coefficient matrix being modified (Matrix A*) and s_j refers to the diagonal matrix of column modifiers.

This iterative process will converge under certain necessary and sufficient conditions (Bacharach 1970). The procedure is an iterative algorithm that alternately meets, at each iteration, row, or column totals by changing the coefficients a_{ij}.

The problem of estimating an Input Output table of NxN counts, then, consists of identifying N2 nonnegative parameters, but having only 2 x N-1 independent column and row constraints. The RAS procedure imposes biproportional conditions, to reduce the problem to that of finding 2 x N-1 coefficients of total sum of row and columns, deriving a unique solution.

Appendix 3. 2017 Argentina MRIO matrix - 35 sectors table

Table 3.1. 2017 Argentina MRIO matrix: value added per activity (35 sectors) and region (3 provinces and RoA) - % and millions of current Argentinian pesos (MM AR$)

Sector	GVA sectoral distribution to each region				GVA geographical distribution to each sector				Total (MM AR$)
	Jujuy	Salta	Catamarca	Rest. Arg	Jujuy	Salta	Catamarca	Rest. Arg	
Agricultura, Cattle Rising, silvicultura and Fishing	4.5%	8.5%	3.2%	6.2%	0.8%	2.1%	0.6%	96.5%	557,703
Oil, gas and Coil Extraction	0.4%	3.2%	0.0%	2.8%	0.1%	1.8%	0.0%	98.1%	248,728
Lithium	1.5%	0.0%	1.2%	0.0%	55.5%	0.0%	44.4%	0.0%	2,624
Mining	2.3%	0.3%	34.6%	0.3%	3.6%	0.7%	52.8%	42.8%	63,540
Food and Beberage	2.6%	4.8%	2.1%	4.8%	0.6%	1.6%	0.5%	97.4%	426,585
Textile Products	0.3%	0.4%	1.4%	1.1%	0.3%	0.6%	1.4%	97.6%	95,004
Wood Products	2.6%	0.5%	0.2%	1.3%	2.2%	0.6%	0.2%	97.0%	116,029
Fuels	0.0%	1.0%	0.0%	0.4%	0.0%	4.4%	0.0%	95.5%	32,434
Chemicals	0.1%	0.7%	0.2%	2.0%	0.0%	0.5%	0.1%	99.3%	174,525
Plastic and Rubber	0.0%	0.0%	0.4%	0.7%	0.0%	0.1%	0.6%	99.3%	64,548
Non-Methalic Minerals	0.8%	0.1%	1.4%	0.7%	1.3%	0.3%	2.2%	96.2%	61,820
Common Metals and Metal Products	1.4%	0.2%	0.3%	1.6%	1.0%	0.2%	0.2%	98.6%	142,881
Machinery and Equipment	0.1%	0.3%	0.3%	1.6%	0.1%	0.3%	0.2%	99.4%	137,761
Vehicles, Trailers and Semi-Trailers	0.0%	0.1%	0.0%	0.7%	0.0%	0.2%	0.0%	99.8%	61,162
Electric Vehicles	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0
Transport Equipment	0.0%	0.0%	0.0%	0.1%	0.0%	0.4%	0.0%	99.6%	5,475
Cells	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0
Battery Pack	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0
Machinery for Renewable Generation	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0
Rest of Industry	0.5%	0.8%	0.6%	0.5%	1.1%	2.3%	1.2%	95.4%	47,391
Non-Termic Generation of Electricity	0.3%	0.3%	0.3%	0.3%	1.1%	1.5%	1.1%	96.3%	25,031
Termic Generation of Electricity	0.8%	0.8%	0.8%	0.8%	1.1%	1.5%	1.1%	96.3%	71,402
Transport and Distribution of Electricity	0.5%	0.5%	0.5%	0.5%	1.1%	1.5%	1.1%	96.3%	44,674
Gas Distribution	0.2%	0.2%	0.0%	0.2%	1.3%	1.4%	0.2%	97.1%	18,412
Water and Sanitation	0.5%	0.8%	0.2%	0.3%	2.0%	4.4%	0.7%	92.9%	24,764
Construction	7.1%	6.3%	2.8%	5.0%	1.6%	1.9%	0.6%	95.9%	455,253
Commerce	15.1%	18.5%	13.2%	16.3%	1.0%	1.8%	0.9%	96.3%	1,467,211
Host Services, Bars and Restaurants	2.3%	1.4%	0.7%	2.6%	1.0%	0.8%	0.3%	97.9%	231,006
Transport	2.7%	2.3%	1.4%	4.1%	0.8%	0.9%	0.4%	98.0%	360,621
Communication	4.2%	2.2%	2.6%	2.6%	1.7%	1.3%	1.1%	95.9%	238,945
Financial Servicies	2.3%	3.9%	0.8%	4.7%	0.5%	1.3%	0.2%	98.0%	418,552
Real State and Bussiness Activities	10.1%	13.9%	8.7%	11.7%	1.0%	1.8%	0.8%	96.4%	1,050,371
Public Administration and Defence	20.2%	10.2%	7.6%	9.0%	2.5%	1.7%	0.9%	94.9%	820,816
Health and Education	14.3%	15.7%	12.9%	12.6%	1.2%	1.9%	1.1%	95.8%	1,143,300
Other Servicies	2.3%	2.1%	1.7%	4.4%	0.6%	0.8%	0.4%	98.2%	384,792
Total	**99,718**	**139,049**	**97,085**	**8,657,509**	**1.1%**	**1.5%**	**1.1%**	**96.3%**	**8,993,361**

Source: Own elaboration based on the 2017 Argentina MRIO matrix

Appendix 4. Satellite employment account

Table 4.1. 2017 Argentina SAE: total employment (jobs) at 35 sectors and 4 regions of the MRIO matrix

MIP CODE	CODE	SECTOR DESCRIPTION	CATAMARCA	JUJUY	SALTA	REST OF ARGENTINA	TOTAL ARGENTINA
1	AGRIC	Primary Industry	12,250	25,402	49,816	1,287,408	1,374,876
2	PYGAS	Primary Industry	0	0	654	68,935	69,589
3	LITIO	Primary Industry	297	268	0	0	565
4	MINER	Primary Industry	150	246	561	24,879	25,836
5	ALIBT	Industrial Activity	3,236	5,753	17,331	639,530	665,849
6	TXYCU	Industrial Activity	3,218	2,062	4,700	392,467	402,447
7	MDYPA	Industrial Activity	987	2,491	3,971	209,185	216,635
8	REFIN	Industrial Activity	0	0	0	6,592	6,592
9	QUIMI	Industrial Activity	299	474	3,308	120,588	124,670
10	PLAST	Industrial Activity	197	0	2,195	88,220	90,612
11	NOMET	Industrial Activity	583	1,475	1,765	62,102	65,925
12	SIDER	Industrial Activity	1,488	2,452	4,526	268,365	276,832
13	MAQUI	Industrial Activity	868	1,058	2,792	235,786	240,505
14	VEHIC	Industrial Activity	0	212	0	80,910	81,122
15	AUELE	Industrial Activity	0	0	0	0	0
16	EQTRA	Industrial Activity	0	0	0	18,691	18,691
17	BCELD	Industrial Activity	0	0	0	0	0
18	BPACK	Industrial Activity	0	0	0	0	0
19	PANEL	Industrial Activity	0	0	0	0	0
20	INDUR	Industrial Activity	597	1,359	2,926	139,223	144,105
21	GRENO	Electricity, gas, and Water	0	0	0	0	0
22	GDELE	Electricity, gas, and Water	699	334	1,090	34,434	36,556
23	DIELE	Electricity, gas and Water	354	366	512	32,000	33,233
24	DIGAS	Electricity, gas, and Water	24	240	735	14,278	15,277
25	DIAGU	Electricity, gas, and Water	273	604	897	38,940	40,714
26	CONST	Services	15,812	21,805	49,317	1,586,970	1,673,903
27	COMER	Services	25,478	48,538	81,373	3,404,702	3,560,090
28	HOYRE	Services	7,253	13,517	37,115	614,780	672,665
29	TRANS	Transport	3,917	8,575	16,861	976,605	1,005,958
30	COMUN	Services	640	1,740	2,886	176,291	181,557
31	FINAN	Services	2,730	3,066	5,444	293,581	304,821
32	SEMPR	Services	3,810	7,874	22,559	1,322,426	1,356,669
33	ADMPU	Services	29,870	38,946	39,011	1,467,640	1,575,468
34	EDYSA	Services	32,645	58,970	72,802	3,190,998	3,355,414
35	SERVR	Services	20,522	28,362	69,765	2,608,842	2,727,491
	TOTAL		168,196	276,191	494,913	19,405,366	20,344,666

Source: Own elaboration

Appendix 5. Information to the prospective scenarios of LVC design

Table 5.1. Conservative assumptions (projects) for lithium production scenario (2021–2030)

Project	Operator	Province	2022	2025	2030
Fenix (Hombre Muerto)	Livent	Catamarca	20,000	40,000	60,000
Olaroz	Sales de Jujuy (Allkems, Toyota Tsusho, JEMSE)	Jujuy	17,000	37,000	42,000
Cauchari-Olaroz	Minera Exar (Lithium Americas, Ganfeng, JEMSE)	Jujuy		30,000	42,000
Sal de los Ángeles	Lithium-X	Salta			25,000
Sal de Vida	Allkems	Catamarca			25,000
Salar del Rincón	Rincon Lithium (acquisition by Rio Tinto in progress)	Salta			25,000
Pastos Grandes	Lithium Americas	Salta			24,000
Tres Quebradas	Neo Lithium	Catamarca			25,000
Sal de Oro	POSCO	Salta/Catamarca			25,000
Rincon Lithium Project	Argosy Minerals	Salta			10,000
Total				**107,000**	**303,000**

Source: Own elaboration

Table 5.2. Moderate assumptions (projects) for lithium production scenario (2021–2030)

Project	Operator	Province	Expected production capacity(Tn LCE / year)	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Fenix (Hombre Muerto)	Livent	Catamarca	20,000	20,000	20,000	26,666	33,333	40,000	40,000	40,000	40,000	40,000	40,000
				Construction									
Olaroz	Sales de Jujuy (Allkems, Toyota Tsusho, JEMSE)	Jujuy	17,500	13,000	13,000	25,500	38,000	38,000	38,000	38,000	38,000	38,000	38,000
				Construction									
Cauchari-Olaroz	Minera Exar (Lithium Americas, Ganfeng, JEMSE)	Jujuy	40,000	0	9,800	28,150	40,000	40,000	40,000	40,000	46,666	53,333	60,000
				Construction					Construction				
Pastos Grandes	Lithium Americas	Salta	24,000		0	0	0	0	0	0	8,000	16,000	24,000
									Construction				
Sal de Oro	POSCO	Salta/Catamarca	32,000		0	0	0	8,333	16,666	25,000	25,000	25,000	25,000
						Construction							
Sal de Vida	Allkems	Catamarca	Stg1 10,700		0	3,333	6,666	10,700	10,700	10,700	10,700	10,700	18,033
			Stg2 32,000	Construction							Construction		
Rincon Lithium Project	Argosy Minerals	Salta	10,000		0	666	1,333	2,000	2,000	2,000	2,000	6,000	10,000
				Construction							Construction		
Salar del Rincón	Rincon Lithium (acquisition by Rio Tinto in progress)	Salta	25,000		0	0	0	0	0	8,333	16,666	25,000	25,000
								Construction					
Tres Quebradas	Neo Lithium	Catamarca	20,000		0	0	0	0	6,666	13,333	20,000	20,000	20,000
							Construction						
Centenario Ratones	Eramet	Salta	24,000		0	0	0	6,000	18,000	24,000	24,000	24,000	24,000
						Construction							
Mariana (Salar de Llullaillaco)	Litio Minera Argentina (Ganfeng, International Lithium)	Salta	20,000		0	0	0	0	0	0	6,666	13,333	20,000
									Construction				
Sal de los Ángeles	Lithium-X	Salta	25,000		0	0	0	0	0	0	0	0	8,333
											Construction		
Kachi	Lake Resources	Catamarca	25,500		0	0	0	0	0	0	0	0	8,500
											Construction		
				33,000	**42,800**	**84,315**	**125,332**	**165,366**	**180,366**	**201,366**	**237,698**	**271,366**	**320,866**

Source: Own elaboration

Table 5.3. Optimistic assumptions (projects) for lithium production scenario (2021–2030)

Project	Operator	Province	Expected production capacity (Tn LCE / year)	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Fenix (Hombre Muerto)	Livent	Catamarca	20,000	20,000	20,000	26,666	33,333	40,000	40,000	40,000	46,666	53,333	60,000
				Construction					Construction				
Olaroz	Sales de Jujuy (Allkems, Toyota Tsusho, JEMSE)	Jujuy	17,500	13,000	17,500	30,000	42,500	42,500	42,500	42,500	55,000	67,500	67,500
									Construction				
Cauchari-Olaroz	Minera Exar (Lithium Americas, Ganfeng, JEMSE)	Jujuy	40,000	0	9,800	28,150	40,000	40,000	40,000	46,666	53,333	60,000	60,000
				Construction				Construction					
Pastos Grandes	Lithium Americas	Salta	24,000	0	0	0	0	8,000	16,000	24,000	24,000	24,000	24,000
						Construction							
Sal de Oro	POSCO	Salta/Catamarca	25,000	0	0	0	8,333	16,666	25,000	25,000	25,000	25,000	25,000
					Construction								
Sal de Vida	Allkems	Catamarca	25,000	0	0	2,500	7,500	10,000	10,000	21,000	32,000	32,000	32,000
				Construction									
Rincon Lithium Project	Argosy Minerals	Salta	10,000	0	666	1,333	2,000	2,000	4,666	7,333	10,000	10,000	10,000
				Construction			Construction						
Salar del Rincón	Rincon Lithium (acquisition by Rio Tinto in progress)	Salta	50,000	0	0	0	0	12,500	25,000	37,500	50,000	50,000	50,000
Tres Quebradas	Neo Lithium	Catamarca	20000 (expandable to 40000)	0	0	0	0	6,666	13,333	20,000	26,666	33,333	40,000
						Construction			Construction				
Centenario Ratones	Eramet	Salta	24,000	0	0	0	6,000	18,000	24,000	24,000	24,000	24,000	24,000
					Construction								
Mariana (Salar de Llullaillaco)	Litio Minera Argentina (Ganfeng, International Lithium)	Salta	20,000	0	0	0	6,666	13,333	20,000	20,000	20,000	20,000	20,000
					Construction								
Sal de los Ángeles	Tibet Summit	Salta	25,000	0	0	0	0	0	0	0	8,333	16,666	25,000
									Construction				
Kachi	Lake Resources	Catamarca	25,500	0	0	0	0	0	0	0	8,500	17,000	25,500
									Construction				
Total				**33,000**	**47,966**	**88,649**	**146,332**	**209,665**	**260,499**	**307,999**	**383,498**	**432,832**	**463,000**

Source: Own elaboration

Appendix 6. LVC simulation scenarios - additional results

Table 6.1. GDP, tax revenue, exports and employment impacts under the LVC scenarios (lithium and cell production) in 2022

LVC production impacts by 2022			
Variables	Direct & Indirect	Induced	Total
CONSERVATIVE			
Value of production (MM AR$)	78%	22%	**12,517**
GDP (MM AR$)	79%	21%	**5,449**
Employment (#)	47%	53%	**5,982**
Tax revenue (MM AR$)	79%	21%	**1,429**
Output multiplier	*1.66*		***2.14***
Employment multiplier	*3.95*		***8.41***
MODERATE			
Value of production (MM AR$)	78%	22%	**14,474**
GDP (MM AR$)	79%	21%	**6,298**
Employment (#)	46%	54%	**6,918**
Tax revenue (MM AR$)	78%	22%	**1,659**
Output multiplier	*1.66*		***2.14***
Employment multiplier	*4.00*		***8.61***
OPTIMISTIC			
Value of production (MM AR$)	79%	21%	**17,282**
GDP (MM AR$)	80%	20%	**7,385**
Employment (#)	48%	52%	**8,071**
Tax revenue (MM AR$)	79%	21%	**2,019**
Output multiplier	*1.63*		***2.08***
Employment multiplier	*3.69*		***7.76***

Source: Own elaboration

Note: Results are presented in increases compared to the 2017 MRIO & SAE. Conservative and Moderate scenarios consider lithium production shocks while the Optimistic one also adds a cell production shock in the total impact. Total impact is decomposed in direct & indirect vs. induced effects of the total impact in each variable. Output and Employment multipliers correspond to the open MRIO model that allows computing direct & indirect effects, and to the close MRIO model that also adds the induced effect due to households' consumption.

Table 6.2. Regional production, GGP, tax revenue (MM AR$) and employment (jobs) impacts under the LVC scenarios (lithium and cell production) in 2022

LVC impacts by 2022								
	Catamarca		Jujuy		Salta		Rest of Argentina	
Variables	Total	% of 2022 BAU	Total	% of 2022 BAU	Total	% of 2022 BAU	Total	% of 2022 BAU
CONSERVATIVE								
Value of production (MM AR$)	4,499	2.66%	3,758	2.01%	52	0.02%	4,209	0.02%
GGP (MM AR$)	2,054	2.34%	1,712	1.93%	24	0.02%	1,659	0.02%
Employment (#)	1,738	1.00%	1,483	0.52%	81	0.02%	2,681	0.01%
Tax revenue (MM AR$)	467	1.75%	411	1.46%	8	0.02%	544	0.02%
MODERATE								
Value of production (MM AR$)	4,503	2.67%	5,035	2.69%	60	0.02%	4,875	0.03%
GGP (MM AR$)	2,056	2.34%	2,293	2.59%	28	0.02%	1,921	0.02%
Employment (#)	1,741	1.00%	1,982	0.69%	93	0.02%	3,102	0.02%
Tax revenue (MM AR$)	467	1.75%	551	1.95%	9	0.02%	632	0.02%
OPTIMISTIC								
Value of production (MM AR$)	4,549	2.69%	6,067	3.24%	223	0.08%	6,443	0.03%
GGP (MM AR$)	2,078	2.37%	2,763	3.12%	102	0.08%	2,442	0.03%
Employment (#)	1,762	1.01%	2,386	0.83%	197	0.04%	3,726	0.02%
Tax revenue (MM AR$)	473	1.77%	664	2.35%	28	0.07%	854	0.03%

Source: Own elaboration

Note: Results are presented in increase compared to the 2017 MRIO & SAE and in terms of % change in terms of the BAU baseline in 2022. Conservative and Moderate scenarios consider lithium production shocks while the Optimistic one also adds a cell production shock in the total impact. Total national impacts are regionally decomposed between rich-Lithium provinces and the rest of Argentina in each variable.

Table 6.3. Sectoral production (MM AR$) and employment (jobs) impacts under the LVC scenarios (lithium and cell production) in 2022

LVC impact by 2022				
Sectors	Production		Employment	
	MM AR$	% of total	#	% of total
CONSERVATIVE				
Agriculture, cattle, silviculture & fishing	235	1.88%	336	5.61%
Rest of mining, oil & gas	429	3.43%	79	1.32%
Lithium	6,125	48.93%	745	12.45%
Rest of industries	1,097	8.76%	739	12.35%
Fuels	216	1.72%	5	0.09%
Chemicals	1,367	10.92%	287	4.80%
Batteries, cell production	0	0.00%	0	0.00%
Batteries, packs production	0	0.00%	0	0.00%
Electricity generation & distribution	272	2.17%	115	1.93%
Water & gas distribution	126	1.01%	63	1.06%
Construction	27	0.22%	50	0.83%
Commerce	475	3.80%	759	12.69%
Host Services, Bars & Restaurants	118	0.94%	294	4.91%
Transport & Communications	822	6.57%	644	10.76%
Financial, real states & business services	900	7.19%	597	9.99%
Rest of services	309	2.47%	1,269	21.22%
TOTAL	**12,517**		**5,982**	
MODERATE				
Agriculture, cattle, silviculture & fishing	274	1.89%	394	5.70%
Rest of mining, oil & gas	499	3.44%	92	1.33%
Lithium	7,082	48.93%	841	12.16%
Rest of industries	1,275	8.81%	883	12.76%
Fuels	246	1.70%	6	0.09%
Chemicals	1,592	11.00%	335	4.84%
Batteries, cell production	0	0.00%	0	0.00%
Batteries, packs production	0	0.00%	0	0.00%
Electricity generation & distribution	300	2.07%	127	1.84%
Water & gas distribution	156	1.08%	77	1.11%
Construction	31	0.22%	57	0.82%
Commerce	552	3.82%	890	12.86%
Host Services, Bars & Restaurants	143	0.99%	344	4.97%
Transport & Communications	925	6.39%	721	10.43%
Financial, real states & business services	1,041	7.19%	695	10.05%
Rest of services	356	2.46%	1,455	21.04%
TOTAL	**14,474**		**6,918**	
OPTIMISTIC				
Agriculture, cattle, silviculture & fishing	311	1.80%	450	5.58%
Rest of mining, oil & gas	564	3.26%	104	1.29%
Lithium	7,992	46.24%	936	11.60%
Rest of industries	1,454	8.41%	1,025	12.70%
Fuels	277	1.60%	7	0.09%
Chemicals	1,800	10.42%	379	4.70%
Batteries, cell production	758	4.38%	154	1.91%
Batteries, packs production	111	0.64%	23	0.28%
Electricity generation & distribution	328	1.90%	139	1.73%
Water & gas distribution	183	1.06%	89	1.11%
Construction	36	0.21%	64	0.80%
Commerce	632	3.66%	1,023	12.68%
Host Services, Bars & Restaurants	167	0.97%	399	4.95%
Transport & Communications	1,054	6.10%	817	10.13%
Financial, real states & business services	1,209	6.99%	803	9.95%
Rest of services	405	2.35%	1,656	20.52%
TOTAL	**17,282**		**8,071**	

Source: Own elaboration.

Note: Results are presented in increase compared to the 2017 MRIO & SAE and in terms of % change in terms of the BAU baseline in 2022. Conservative and Moderate scenarios consider lithium production shocks while the Optimistic one also adds a cell production shock in the total impact. Total national impacts are sectorally decomposed presented in terms of absolute and % of total gains.

Table 6.4. production, GDP, tax revenue and employment impacts under the LVC scenarios (investment & production) in 2025 and 2030

	Investment shocks						Production shocks					
	LVC impacts by 2025			LVC impacts by 2030			LVC impacts by 2025			LVC impacts by 2030		
Variables	Direct & Indirect	Induced	Total	Direct & Indirect	Induced	Total	Direct & Indirect	Induced	Total	Direct & Indirect	Induced	Total
CONSERVATIVE												
Value of production (MM ARS)	85.8%	14.2%	**18,418**	85.0%	15.0%	**62,514**	77.5%	22.5%	**23,648**	79.4%	20.6%	**91,259**
GDP (MM ARS)	84.7%	15.3%	**6,772**	84.2%	15.8%	**23,700**	79.5%	20.5%	**10,282**	80.4%	19.6%	**38,425**
Employment (#)	82.7%	17.3%	**17,485**	81.4%	18.6%	**66,113**	45.2%	54.8%	**11,308**	46.6%	53.4%	**46,395**
Tax revenue (MM ARS)	85.7%	14.3%	**7,940**	85.7%	14.3%	**7,940**	77.0%	23.0%	**2,739**	79.3%	20.7%	**11,084**
Output multiplier	*1.80*		***2.10***	*1.75*		***2.06***	*1.66*		***2.14***	*1.59*		***2.01***
Employment multiplier	*1.61*		***1.95***	*1.54*		***1.89***	*4.07*		***8.88***	*3.56*		***7.62***
MODERATE												
Value of production (MM ARS)	85.6%	14.4%	**28,311**	85.1%	14.9%	**74,216**	77.3%	22.7%	**36,506**	79.7%	20.3%	**109,700**
GDP (MM ARS)	84.5%	15.5%	**10,523**	84.3%	15.7%	**28,084**	79.2%	20.8%	**15,896**	80.6%	19.4%	**45,954**
Employment (#)	82.2%	17.8%	**27,930**	81.2%	18.8%	**78,258**	44.6%	55.4%	**18,198**	46.8%	53.2%	**55,659**
Tax revenue (MM ARS)	85.6%	14.4%	**9,440**	85.6%	14.4%	**9,440**	76.8%	23.2%	**4,259**	79.5%	20.5%	**13,402**
Output multiplier	*1.78*		***2.08***	*1.76*		***2.06***	*1.66*		***2.14***	*1.58*		***1.98***
Employment multiplier	*1.58*		***1.93***	*1.55*		***1.91***	*4.10*		***9.07***	*3.49*		***7.45***
OPTIMISTIC												
Value of production (MM ARS)	85.4%	14.6%	**45,371**	84.9%	15.1%	**110,212**	77.9%	22.1%	**61,224**	79.4%	20.6%	**161,423**
GDP (MM ARS)	84.4%	15.6%	**17,037**	84.0%	16.0%	**41,947**	79.6%	20.4%	**26,349**	80.3%	19.7%	**68,002**
Employment (#)	81.4%	18.6%	**46,724**	81.6%	18.4%	**117,412**	44.5%	55.5%	**31,887**	47.0%	53.0%	**81,473**
Tax revenue (MM ARS)	85.8%	14.2%	**13,977**	85.8%	14.2%	**13,977**	77.2%	22.8%	**7,333**	79.6%	20.4%	**19,514**
Output multiplier	*1.77*		***2.07***	*1.75*		***2.06***	*1.64*		***2.10***	*1.58*		***2.00***
Employment multiplier	*1.58*		***1.94***	*1.52*		***1.86***	*3.95*		***8.81***	*3.51*		***7.47***

Source: Own elaboration

Note: Results are presented for 2025 and 2030 as increases compared to the 2022 Conservative results (Total columns). Total impacts are decomposed into direct, indirect, and induced effects (in % of total impacts) for each variable. Shock of investment and production are presented separately.

Table 6.5. Regional production, GDP, tax revenue and employment total impacts under the LVC scenarios (investment & production) in 2025 and 2030

	Investment shocks								Production shocks							
	LVC impacts by 2025				LVC impacts by 2030				LVC impacts by 2025				LVC impacts by 2030			
	Catamarca	Jujuy	Salta	Rest of Argentina	Catamarca	Jujuy	Salta	Rest of Argentina	Catamarca	Jujuy	Salta	Rest of Argentina	Catamarca	Jujuy	Salta	Rest of Argentina
CONSERVATIVE																
Value of production (MM ARS)	2,796	6,893	111	8,617	8,994	9,398	15,234	28,888	4,523	11,026	97	8,002	15,697	15,002	25,148	35,412
GDP (MM ARS)	1,182	2,269	52	3,270	3,807	3,113	5,759	11,021	2,066	5,022	45	3,149	7,264	6,833	11,399	12,929
Employment (#)	3,945	6,691	197	6,653	12,654	9,179	21,815	22,465	1,756	4,322	151	5,078	6,286	5,984	15,111	19,014
Tax revenue (MM ARS)	346	742	18	1,116	1,115	1,018	2,038	3,769	470	1,207	14	1,048	1,741	1,645	2,905	4,793
MODERATE																
Value of production (MM ARS)	4,293	8,434	2,397	13,186	9,462	11,357	19,031	34,366	7,107	13,466	3,866	12,067	16,582	18,117	31,430	43,572
GDP (MM ARS)	1,815	2,779	916	5,012	4,016	3,762	7,192	13,115	3,260	6,133	1,753	4,749	7,692	8,252	14,247	15,763
Employment (#)	6,057	8,195	3,471	10,206	13,207	11,090	27,244	26,717	2,788	5,294	2,417	7,700	6,686	7,223	18,865	22,886
Tax revenue (MM ARS)	531	908	324	1,712	1,176	1,230	2,545	4,489	755	1,474	449	1,581	1,862	1,986	3,630	5,924
OPTIMISTIC																
Value of production (MM ARS)	5,269	9,122	9,884	21,097	19,031	15,526	24,925	50,730	9,127	14,604	16,288	21,205	32,982	24,702	41,112	62,628
GDP (MM ARS)	2,241	3,014	3,739	8,044	8,028	5,147	9,426	19,346	4,231	6,652	7,383	8,083	15,216	11,252	18,636	22,898
Employment (#)	7,302	8,885	14,164	16,373	27,051	15,175	35,708	39,478	3,676	5,779	9,806	12,625	13,096	9,876	24,750	33,751
Tax revenue (MM ARS)	656	985	1,323	2,754	2,351	1,683	3,335	6,607	1,021	1,600	1,882	2,831	3,605	2,709	4,750	8,449

Source: Own elaboration

Table 6.6. Sectoral production and employment total impacts under the LVC scenarios (LVC production shocks) in 2025 and 2030

	2025		2030	
Sectors	Production (MM AR$)	Employment (#)	Production (MM AR$)	Employment (#)
CONSERVATIVE				
Agriculture, cattle, silviculture & fishing	692	363	1,807	2,672
Rest of mining, oil & gas	1,252	197	3,051	560
Lithium	17,697	2,038	45,868	5,506
Rest of industries	3,210	2,092	8,630	6,570
Fuels	601	15	1,878	38
Chemicals	4,015	831	9,627	2,091
Cells	0	0	2,464	501
Battery packs	0	0	6,381	1,296
Electricity generation & distribution	706	193	1,729	741
Water & gas distribution	425	185	876	468
Construction	78	78	219	403
Commerce	1,390	1,598	3,786	6,206
Host Services, Bars & Restaurants	380	843	975	3,526
Transport & Communications	2,231	1,492	6,488	6,323
Financial, real state & business services	2,603	1,460	7,526	4,789
Rest of services	883	3,064	2,471	10,687
TOTAL	**36,165**	**14,449**	**103,776**	**52,377**
MODERATE				
Agriculture, cattle, silviculture & fishing	939	518	2,099	3,118
Rest of mining, oil & gas	1,666	260	3,521	647
Lithium	23,966	2,790	53,098	6,337
Rest of industries	4,338	2,904	10,123	7,784
Fuels	860	19	2,194	45
Chemicals	5,323	1,112	11,105	2,420
Cells	0	0	2,674	543
Battery packs	0	0	9,421	1,914
Electricity generation & distribution	938	258	1,953	837
Water & gas distribution	544	241	1,025	547
Construction	107	109	255	471
Commerce	1,892	2,197	4,431	7,286
Host Services, Bars & Restaurants	514	1,332	1,149	4,212
Transport & Communications	3,100	2,282	7,506	7,430
Financial, real state & business services	3,617	2,003	8,789	5,582
Rest of services	1,219	4,337	2,874	12,469
TOTAL	**49,023**	**20,360**	**122,218**	**61,641**
OPTIMISTIC				
Agriculture, cattle, silviculture & fishing	1,357	836	3,005	4,427
Rest of mining, oil & gas	2,331	354	5,093	934
Lithium	32,100	4,078	76,593	9,290
Rest of industries	5,927	4,562	14,476	10,853
Fuels	1,367	33	3,145	63
Chemicals	7,409	1,539	16,045	3,480
Cells	2,046	416	2,883	586
Battery packs	300	61	12,461	2,531
Electricity generation & distribution	1,237	366	2,964	1,269
Water & gas distribution	645	417	1,416	763
Construction	155	161	367	679
Commerce	2,727	3,237	6,327	10,335
Host Services, Bars & Restaurants	702	1,771	1,593	5,821
Transport & Communications	4,562	2,852	10,925	10,610
Financial, real state & business services	5,539	2,913	12,517	7,956
Rest of services	1,759	6,277	4,128	17,857
TOTAL	**70,163**	**29,872**	**173,940**	**87,455**

Source: Own elaboration